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National Fire Protection Association.

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Franklin H. Wentworth, Secretary

April, 1918

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Western Insurance Bureau.
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West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.
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Reports on fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

EFFECT OF BACK DRAUGHT.

Twenty New York City firemen were injured when back draught tore off the rear wall of the fire-resistive building of the New York Cordage Co., driving iron shutters and parts of a heavy iron stairway against the walls of nearby structures.

The Quarterly

Vol 11. **April, 1918.** **No. 4**

Twenty-second Annual Meeting. The influence of the war will inevitably be felt at the twenty-second annual meeting of the Association, which is to be held in Chicago on May 7th, 8th and 9th. On the one hand, the assumption of new or additional responsibilities by the chairmen of one or two committees may involve the postponement for a year of the consideration of particular technical problems; on the other hand, the presentation which is to be given of the activities of our member, the National Board of Fire Underwriters, during the present crisis will vividly bring home to members the importance of maintaining in full vigor at this time every agency of fire protection and prevention.

Notwithstanding the difficulties mentioned above, a number of committee reports involving matters of moment will come before the meeting. The committee on *Field Practice* has been considering the whole question of "first aid" hand fire protection, in addition to continuing its investigations of the problem of gate valve control; contributions of great importance will be made by the committees on *Fire-Resistive Construction* and on the *Uses of Wood in Building Construction;* thorny questions of orismology will again be brought up for discussion by the committee on *Nomenclature;* the committee on *Safety to Life* will ask for final acceptance by the Association of a standard method of establishing the number of persons that may with reasonable safety be permitted in buildings of different types under a variety of conditions; and the committee on *Tanks* has prepared detailed specifications of performance in connection with the installation of scuppers. Several other committees are also expected to report.

The "round table" this year will be on the subject of *Fire Protection in Hotels and Apartment Houses,* and it is also planned to have a special discussion on *Zero Weather Hazards.*

A new feature will be the luncheon on Wednesday, May 8th, at the Hotel La Salle, to be addressed by Dr. Gunsaulus, President of the Armour Institute of Technology. This is to be followed by an official visit to Underwriters' Laboratories. The official program containing full details will probably be in members' hands before they receive this issue of the QUARTERLY.

Fire Menace at Camp Lewis. Fire Marshal Harry W. Bringhurst, of Seattle, in a recent letter to the N. F. P. A., draws attention to a growing fire menace on the Government reservation adjoining the large Army cantonment at Camp Lewis. A large area, known as "Greene Park," is being developed as a sort of "joy zone" or "midway," not only for the relatives and friends of the soldiers, but for automobile parties from the whole Puget Sound country. This is what Mr. Bringhurst has to say about the conditions:

> The Greene Park tract is separated from the soldiers by railway tracks and a highway. It is divided into fourteen blocks, the subdivisions of these being leased to various individuals and companies, for whom a syndicate puts up buildings, as I was informed. At any rate, this large tract is being covered with structures of temporary design and of the most inflammable character. . . . The hotel is to have 560 rooms and is to be all frame. There are to be large theatres, billiard halls, stores, garages, dry cleaning places, and so on. There are not intervals enough between the buildings to be of service, every roof is or is to be shingled, and there is not a handful of plaster on the grounds so far as I could see. Each building is simply a shell with rustic siding outside of the studding and some variety of composition lining inside in lieu of lath and plaster. . . . Some of this lining appears to be only a thin slab or veneer of ordinary cedar, with paper pasted on each side. A building so built and lined would burn like a paper box.

The location is remote from the fire stations and access is by way of an overhead viaduct to be built over the highway and railway tracks. The grades are to be 15 per cent., and it is doubtful whether the small automobile hose wagons with which the camp is furnished could be depended upon to get over these. The nearest camp buildings are the hospitals, and although at present they stand at a safe distance, it is reported that the vacant area will soon be built upon. The great moving picture theatre has an open lattice ceiling, and Mr. Bringhurst thinks that, in the event of a panic and "jam," the heavy roof trusses might burn away and allow the whole thing to collapse before the entire audience could be gotten out.

It is devoutly to be hoped that the Government will take prompt and drastic action with a view to safeguarding the lives of those who may patronize "Greene Park" during the coming months.

* * * * *

The Quaker Oats Co. Fire Recalled. Readers who remember the report which was printed in the QUARTERLY a year ago (Vol. 10, No. 4, p. 381) in connection with the disastrous fire which wrecked the plant of the Quaker Oats Company at Peterboro, Ontario, on December 11, 1916, will be interested in the remarks made by Mr. J. W. Lowell, Jr., upon a paper dealing with this fire, which was read by Mr. T. D. Mylrea before the *Western Society of Engineers*. In the course of the discussion following the reading of the paper, Mr. Lowell spoke as follows:

> Small industrial fires occurring every day pass unnoticed and only the holocaust causes most of us to stop in our daily tasks and take notice. Therefore, it is by these great fires that we learn the real lessons of fire prevention and thus improve our engineering knowledge and better our capacity for service to mankind.
>
> This paper has been of great interest to me, not because of the fact that

the Quaker Oats Company lost a great deal of business, not because some insurance company lost many thousands of dollars, but because men of our profession failed in their service to their employers and to mankind. By making this statement, I do not mean to cast discredit on any person, nor to criticize them because ignorance of fire prevention engineering is general throughout the profession, and is not considered vital enough to be taught in our colleges. I do feel that our profession must concern itself in the future with the engineering of fire prevention and protection.

To begin with, engineering students should be taught the theory and practical application of this subject. We who are practicing will be benefited greatly by lectures such as the one which we have just heard and others presenting various phases of the subject. Whenever we are called upon to design buildings and groups of buildings, we should bear the fire hazard in mind, as an important factor, and, if we are not competent to solve the problems involved, consult with specialists.

* * * * *

The Truth About "Enemy Fires." We congratulate the National Board of Fire Underwriters upon the bulletin in which it is exposing the mis-statements which have been fathered upon it in connection with losses caused by "enemy fires." The ridiculous story that enemy incendiaries had in recent months been responsible for losses amounting to $43,000,000 is thoroughly discredited. In only about 5 per cent. of the fires which caused the above-mentioned loss was there proof of incendiarism, and in nearly 90 per cent. there was no reason even for suspicion. Our member also administers a well-deserved rebuke to those hysterical persons who talk as though arson was a form of crime unknown in America prior to the war. Feeding the flames of hate is a very different process from staying the flames of conflagration, and it is the latter in which the fire preventionist is interested. It is, of course, necessary to guard against fires of German origin, but little indeed will be the good accomplished if, in doing this, we overlook the urgent duty of guarding against the vastly more numerous and destructive fires of American origin, which will continue to menace the national welfare after the war is over, as they did before it started.

* * * * *

Individual Liability in Mississippi. Although along somewhat different lines from those which the N. F. P. A. is following in its campaign, the principle of the liability of the individual for fires due to his carelessness or neglect is recognized in a bill which has been introduced in the Mississippi Legislature. The text of the bill is as follows:

"Section 1. Be it enacted by the Legislature of the State of Mississippi:

"That it shall be unlawful for any person to set on fire any lands of another without his consent, or wantonly, negligently or carelessly to allow any fire to get into the lands of another, and he shall, on conviction, be fined not less than $10.00 nor more than $50.00, or be imprisoned in the county jail not exceeding three months, or both.

"Section 2. That this act take effect and be in force from and after its passage."

Fire Hazards of Rat Poisons.

We are indebted to Mr. M. E. H. Sailman, who quite often sends us similar items of news, for the clipping reproduced herewith from a recent issue of the *Toronto Star*:

Rat Poison Sets a Home Ablaze.

KINGSTON, Feb. 1.—The Fire and Light Committee have been trying to ascertain the cause of a fire which badly gutted the home of James Harris, and have come to the conclusion that rat poison, which contained phosphorus, was responsible. It is believed that the poison, which was placed on some bread, was carried by rats to their nest near a hot water pipe, and that it caught fire from the heat. The Fire and Light Committee will take steps to have the sale of the poison prohibited.

This report is of particular interest in view of the experiments made with rat poison by Mr. N. F. Hickey, of which an account is given on another page.

* * * * *

Drastic Safety Match Bill.

The Fire Chiefs' Club of Massachusetts (Member N. F. P. A.) is to be commended for its courage in advocating legislation to prohibit absolutely the manufacture or sale of any but safety "strike-on-box" matches. A bill was actually introduced with this object in the State Legislature, but failed of passage. Mr. Harry E. Lake, secretary to the Fire Prevention Commissioner for the Metropolitan District, who has been very active in co-operating with the Fire Chiefs' Club, has collected considerable data in support of the proposed law. He says:

"The use of matches has been so abused as to cause about 22 percent of all fires in Massachusetts during the past fifteen years, or, in other words, out of 94,000 fires which occurred in that period of time, more than 20,000 were the result of careless use of matches, children playing with matches, rats and matches, and sparks from matches. The fire loss from these causes has been over $12,000,000. . . . In the past two years the writer has cut from two local newspapers reports of the loss of 26 lives from children playing with matches, 20 of which were in the Metropolitan District of Massachusetts. So many little lives cannot be spared for sacrifice at the altar of carelessness. Therefore, if the type of match now marketed cannot be kept out of the reach of children or used properly, some improvement in the type of match or container is imperative. The match companies claim that they cannot obtain the materials to make strike-on-box matches as these are now made, and it remains to be seen whether they will meet the demand in some other way, or whether it will be necessary for legislative action to be taken.

The present "strike-any-where" match without the second dipping appears to answer the requirements for the strike-on-box match. The problem, then, appears to be to provide the box. The only requirements for the box are that it be a proper container and that it have on the outside material in sufficient quantity to ignite all the matches in the box. Apparently this material put on the box can be applied to paper, for the little paraffin matches are in a paper folder, and these are of the strike-on-box type."

In the propaganda on behalf of a "Safety Match" bill, much stress is being laid upon the fact that the dangers of the present type of "strike-any-where" match arise largely from the indifference with which so many citizens regard their obligations to their neighbors and to society as a whole. Quite apart, therefore, from success or failure in relation to the measure which is the immediate goal, this

agitation will surely react favorably upon the general campaign for the enforcement of the principle of individual liability for fires due to carelessness or neglect.

* * * * *

The Timeliness of Fire Prevention Propaganda. The constitution of a Fire Prevention Section of the War Industries Board, among the officers and committeemen of which we observe the names of many prominent N. F. P. A. members, reminds us not only of the importance which attaches to the prevention of fires that may interrupt the high speed production of war supplies, but also of the two strikingly contrasted attitudes of mind which are found among fire preventionists at large coincidently with the absorption of the best known leaders in government work. On the one hand the extraordinary demands for highly technical service in fire prevention have given rise in some quarters to the feeling that the present emergency calls only for work of this character and that efforts along other lines are inopportune. On the other side are ranged those who regard the present situation as offering a unique opportunity to arouse popular interest in the subject and thus develop in the whole community a fire prevention conscience that shall outlast the war. Reports from those who are at work in the "individual liability" campaign and in planning for the observance of Fire and Accident Prevention Day—to say nothing of such undertakings as the Ohio Fire Congress mentioned in the current issue of the *News Letter*—strongly confirm our opinion that the second attitude is, under the conditions now prevailing almost everywhere, a right and wise one.

Rat Poisons Containing Phosphorus.

The drug stores of the country and many department stores have invariably upon their shelves many preparations containing phosphorus, naphtha and other hazardous elements whose presence is not indicated by the label on the container. Many of these preparations are harmless, but some are not and are sold in defiance or ignorance of city ordinances, which ordinances are not enforced because of lax inspection or because the responsibility for their enforcement is not definitely placed.

Mr. N. F. Hickey, Superintendent of Insurance of the New Haven Railroad, recently purchased some rat poison which he had reason to believe contained a hazardous amount of phosphorus.

The poison in question was a thick paste contained in a collapsible metal tube. The paste contained considerable yellow phosphorus, the largest pieces being about 1/80 inches in size. Upon opening the tube, the dense phosphorus fumes emanated and the paste had a very strong odor of yellow phosphorus, which has the property of igniting when dry and in contact with the air. Fifteen pieces of bread about 1 inch square were spread thinly and evenly with the paste and afterwards sprinkled with flour as was directed in the printed directions on the tube. These pieces of bread were distributed about a room and left over night. In the morning not a single piece was to be seen, but search revealed all 15 pieces hidden in corners and out of the way places where they had been dragged by rats and mice.

A banked fire was burning in the range, the bottom of which was raised about 6 inches above the galvanized iron mat upon which it rested, and three pieces of the bread which had been dragged beneath the stove were charred, the phosphorus having oxidized completely in the slow heat, burning the dry bread.

In view of the fact that bread coated with this paste when dragged under a stove would char, it was thought there would have been a possibility of a fire had this action taken place in some warm spot between partitions of a building where there was an accumulation of inflammable dirt.

Laboratory tests, however, conducted later on some of the material which had decomposed to such an extent in the original tube that the paste was converted to a liquid disclosed no charring action below a temperature of 240 degrees F., at which temperature the phosphorus ignited and burned with a bluish flame.

Desiring to secure an expert opinion on the preparation, Mr. Hickey asked the Bureau of Explosives to examine a sample of it. The report of Chas. P. Beistle, the Bureau chemist, was as follows:

The sample was in the form of thick paste consisting largely of sugar and starch, with a small amount of yellow phosphorus suspended in a finely divided condition throughout the mass. Approximately 2½ oz. of the material are packed in a collapsible metal tube with screw cap. On exposure to the air a strong odor of phosphorus is noted and also a slight smoke or fume. The material is not readily ignited owing to the large amount of moisture in the paste.

This paste was spread on bread and also on cotton, and placed in an incubator oven at 100 degrees F. for several days; by this treatment the paste became dried out and brittle, and on rubbing this dry material or crushing it a slight crackling noise was heard, and tiny points of burning phosphorus were seen. These glowing points were very small, and numerous efforts to ignite cotton from them were unsuccessful.

While it cannot be stated positively that such ignition is wholly impossible, it is regarded as highly improbable. Rat and roach poisons of similar composition have been in use for many years, and so far as known no fires have been caused by them.

If others were to follow Mr. Hickey's example in so thoroughly investigating the character of suspected compounds sold for so many uses the aggregate of mysterious fires might be reduced.

Fatal Gas Explosion.

The accompanying photograph, for the use of which we are indebted to the courtesy of Mr. Charles E. Eldridge, of the Kansas Inspection and Fire Prevention Office (Member N. F. P. A.) illustrates very vividly the hazards of rubber hose connections to gas stoves. A leak of natural gas from such a connection was responsible for an explosion which not only ruined a dwelling-house as shown, but also caused the death from burns of the sleeping occupant of the room in which it occurred. The bulging of the walls and the loosening of the roof made complete rebuilding necessary. A portion of the furniture was scorched and only the promptness of neighbors in extinguishing fire in the bedding prevented the burning of the house.

The Influence of Fire Insurance upon Buildings and their Architecture.

By Sir Aston Webb, R. A.*

Insurance on buildings may be said to be of three kinds. There is insurance by the building owner, by the method he adopts in constructing his building to resist and protect it from fire; there is insurance by the State and municipal authorities, requiring certain regulations to be adhered to in erecting buildings; and there is the insurance of the insurance companies, which enables the insured to recover a certain amount of the loss if fire occur. My business is the erection of buildings, which I am naturally anxious should live after me, and in the erection of which I am met at every turn by these restrictions, requirements and laws in relation to fire. These restrictions have in view the prevention of fire and protection from fire; most of them have been shown by experience to be necessary and desirable, a few irritating and useless—in my opinion, at least; while all have a very large influence on the design and arrangement of a building. These building requirements—good and bad—in regard to fires, have been largely made by the State and municipal authorities rather than by insurance companies, though I agree most fully with what your president said in his opening remarks as to the beneficial effect of insurance on the trade and welfare of the community, as without it all progress would undoubtedly stop. At the same time, I think you will find that the community took the first step in fire insurance by endeavoring after sad experience to insure the safety of their buildings for themselves, as far as they could, by improved means of construction. London, for instance, has been practically wiped out by fire four times; first in 962, secondly in 1087, again in 1212, and lastly in the great fire of 1666, only 250 years ago. The story of this last fire has been told too often to need repetition here; suffice it to say that the buildings of London were at that time mostly of timber, pitched without, much as the buildings at Staple Inn in Holborn appear today, and the streets were so narrow that the projecting stories on either side nearly met at the top. The fire started in Pudding Lane, Thames Street, and was only stayed by blowing up houses at the Temple, Smithfield, Aldersgate, and other points. It consumed five-sixths of the city; it cleared an area of some 436 acres and destroyed 132,000 dwelling houses, St. Paul's Cathedral, 89 parish churches, the Royal Exchange, and many other buildings,—the value of the property de-

*From an address before the Insurance Institute of Londor, England.

stroyed being estimated at the time at £10,000,000. This was rather an eye-opener to the worthy citizens of London, who at once began to rebuild, not, unfortunately, on Wren's plan, but each on the exact site upon which his premises had previously stood, so that the streets remained narrow and crooked as before. Within four years the rebuilding was nearly completed, and some one writing in 1690 records that whereas "Before the fire people dwelt in low, dark, wooden houses, they now live in lofty, lightsome, uniform and very stately brick buildings."

Thus it was for the prevention of fire that the old wooden buildings were replaced by their owners in brick, so far as the walls were concerned; and the fact that London has never had another visitation on such a scale proves how efficacious the treatment was. The whole appearance of London was changed from picturesque wood to somewhat monotonous brick, entirely as a means of protection from fire; and as far as I know the principal requirements of fire insurance policies at the present day in the case of domestic buildings insist only on this, that the buildings shall be faced with brick or stone, or the roofs covered with slates or tiles, a precaution adopted 250 years ago by Londoners to insure themselves against a similar disaster.

It would be interesting to know who first suggested this change in the manner of building which appears to have been so unanimously adopted immediately after the great fire. There were no fire insurance offices then, fortunately for them; and if there had been they would probably have been wiped out. Fire insurance was not, I believe, general till at least fifty years later; and I am afraid, therefore, it is not possible to credit insurance offices with the great improvement in construction that then took place. The public took upon themselves their own self-protection at their own cost to avoid a similar catastrophe, under the advice I should say probably of that great genius, Sir Christopher Wren; and though after this reconstruction fires still occurred, they were confined to comparatively limited areas, and thus the idea of insuring on an average gradually came into being. This example of London in the matter of building was followed generally throughout the country, and we find to this day that every country town possesses many fine comfortable brick buildings erected towards the end of the 17th and the beginning of the 18th century.

The regulations now in force with regard to buildings are drawn up with the following objects, and differ in various degrees of stringency in different parts of the country. I presume all are of some interest to those concerned with insurance. They are: Regulations for fire prevention. Regulations for fire protection from one part of a building to another and to adjoining buildings. Regulations for fire extinction and regulations for fire escapes. Of these, by far the most important to property owners is fire prevention, while fire protection is that perhaps most considered by municipal and other authorities. By fire prevention I mean the use of fire-resisting materials in a building wherever possible, not only in its walls, but also in its floors and general finish, such as the provision

of fire-resisting floors and roofs and the elimination of wood as far as possible, the proper construction of flues and fireplaces, the position and construction of boilers and heating apparatus, gas and electric light installations, protection from lightning, and the careful execution of all work which if carelessly done may lead to the destruction of the building.

It may be said that these matters, while they may affect the building, cannot affect the architecture; yet they undoubtedly do. We have seen how they entirely altered the aspect of London in the 17th century. The substitution of concrete and plaster for wood in the construction of floors, roofs and internal finishings greatly affects the interior appearance and architecture of buildings. In France the carpenter has long been practically banished from buildings—iron and concrete are used for floors and roofs, and wood panelings are far less used there than in this country.

Protection from fire is another important point which greatly affects buildings. By this we mean protection against the spread of fire from one building to another when once it has broken out. The most important of these precautions is the erection of brick or stone party walls of specified thicknesses, dividing one building from another and carried up a certain height above the roof,—a precaution the usefulness of which has been proved over and over again.

The great fire of London could never have attained to the proportions it did had this precaution been in use at that time. Wide streets are a great means of protection from the spread of fire from one building to the opposite one. This City of London, I am sorry to say, is a great sinner in this respect, many of the streets not being more than 20 feet to 25 feet wide, which enables the buildings opposite easily to catch alight; and in the past, when fires have cleared an area, the streets have often been rebuilt of the same inadequate width. The fact is that after a fire every one is so anxious to rebuild and resume business that there is no time for proper arrangements to be come to. The precautions against the lateral spread of fire already referred to are of great importance, and I believe in France it is necessary for an owner to effect a certain amount of insurance on the buildings on either side of him.

The provision of iron doors to all openings in division walls is another equally important precaution, together with the proviso that large buildings must be subdivided with party walls, so that no portion of a building is of a capacity of more than 250,000 feet cube, or under certain circumstances up to 450,000 feet cube. The architectural difficulty of the party wall regulations is the appearance of the wall above the roof; but difficulties are made to be overcome, and architects do overcome them. Another regulation, prohibiting all woodwork within 4½ inches from the face of any external wall, grievously affected a certain style of architecture which required the sash frame to be brought to the face of the outer walls. This, however, has been modified in recent years.

The fire brigades do, of course, invaluable service in the protection of buildings, but their work hardly comes under my subject. Preparations for fire extinction do not greatly affect us; though,

should the use of sprinklers be extended to other than buildings of the warehouse class, they would exercise our ingenuity greatly. At present they are confined mainly to commercial buildings where the use of sprinklers externally is, I believe, much relied on, and do undoubtedly present considerable difficulties to the architect. The advantages, however, offered by the companies in the reduction of premiums for this means of protection are great inducements for their use by the public.

Means of escape from fire interfere probably more with buildings than any other fire regulation I know of, yet they are necessary, though perhaps architects have not at present the full measure of meeting the difficulties. A very general requirement that every building should have more than one means of escape from it often leads to very unsightly external iron staircases, to the great disfigurement of many important edifices; in the future new buildings will have to be provided with means of escape in a more permanent manner inside. Stringent regulations are also made as to width of staircases, height and width of treads and risers, and the number of steps in a flight, and, finally, the material of which the staircase is built. It is hardly necessary to say that staircases are the most important of all means of escape, and should be carefully regulated accordingly; but a staircase filled with smoke, however constructed, is also dangerous, and therefore precautions have to be taken in certain cases, though these can be—and often are—overdone. Indeed, this class of regulation should be elastic, otherwise great injustice is done and often absurdities are asked for. Canvas shoots and such like means of escape do not affect us much, and are not, I believe, much commended at the present time. The fire brigade, again, does invaluable work in saving life, which no building regulations can accomplish. The day may not be far distant when every town building will have its own high-pressure water supply and be in direct communication with the nearest fire and police stations.

All halls for public assembly, schools, theatres, restaurants, cinema halls, and so on, are of course under stringent regulations which greatly affect the design and arrangement, though churches and chapels seem singularly free from them. The weakest points of these religious buildings are their organs and heating apparatus, both of which seem to require special precautions. The organ, for instance, is made almost entirely of wood, and the organist is always overhauling his instrument with the aid of a candle. For large manufactories, mills and such-like buildings, where inflammable materials and explosives are stored, there are again numerous special and stringent requirements regarding their construction, too numerous and unnecessary to trouble you with. In speaking of these regulations, I have been referring to those drawn up from time to time for the London area, by the London County Council, the only body outside Parliament which has the power to frame and enforce such laws here; and these form to a great extent the basis for the by-laws in other towns throughout the country, and to a lesser degree in the rural districts also. Insurance companies, I believe, except in special cases, rely on the public authorites to see that these

regulations are carried out without having further inspections of their own. Government is its own insurer and its buildings are exempted from all regulations, though they generally conform pretty closely to them, except in the matter of restricted cubical contents. I have only mentioned in the most elementary manner the principal fire regulations affecting buildings, but I think they will be sufficient and perhaps give some idea of the difficulties an architect has to meet before he can design a structure suitable for its purpose and seemly in appearance.

Without wearying you with unnecessary detail, I think we may take it that the effect of these building regulations, irritating though they sometimes are, has been on the whole beneficial both to architecture and to building, and that they have resulted in a sounder and more substantial method of construction, which in itself is a gain. That they have achieved all that is possible in the direction of fire-resistance cannot be claimed, but as they are mainly drawn up and put into practice by the State and municipal authorities they probably go as far as the liberty of the subject in a free country and commercial enterprise will allow; such regulations can only be general, and if made too stringent would undoubtedly entail great and almost intolerable hardship on a large class of speculative building which the community require. For instance, though it would in theory be desirable that all structures should be of fire-resisting construction, it would in the case of small domestic dwellings so raise the cost as to make their erection at reasonable rentals impracticable; and therefore under present circumstances many an owner does as little as he possibly can under the Building Act and runs the risk of being burned out.

Well, then, if the State and municipal authorities have gone almost as far as they can, and insurance companies have no legal powers to enforce building regulations for the more effective prevention of fires, how can much improvement with the necessary elasticity be obtained? No doubt another great fire of London would do as it did before, but prevention is better than cure, and no one of us wishes to see again so drastic a remedy. We certainly do not want another great fire of London. Were it to happen, I believe that as the last great fire in former years changed London buildings externally from wood to brick, another one would change them internally from wood to concrete; but, failing such a catastrophe, I think we must look to insurance companies to help us to educate the public—and they could certainly do a great deal. I assume, of course, that there is a general desire to prevent fires; though the effort seems generally more towards extinguishing fires rather than preventing them. I have lately read an address by the general manager of a great Scottish office, in which he pointed out that "If there were no fires there would be no insurance," and "that profits cannot be made without fires." That may be perfectly true. I do not know, but it is a condition of affairs never likely to arise. Some statisticians tell us that the fire loss in the British Isles alone is £10,000,000 per annum, and however much we may try to reduce this loss fires will still occur in even the best regulated buildings,

and will continue to occur however careful we may be; but that the waste and misery and loss of life resulting from fires can still be largely reduced I firmly believe, and I feel certain that insurance companies would be willing to assist in attaining so desirable an end.

The present 1s. 6d. insurance policy only requires that a building shall be built externally of brick or stone and roofed with slate or tiles, though special regulations are also made in regard to electric lighting and heating apparatus. These requirements refer to the exterior, and leave such important points as the construction of the roofs, floors, wall linings, etc., untouched. I believe nine fires out of every ten originate in the interior of buildings, and the material with which roofs are constructed (not merely are covered) is a matter of the first importance, as also the composition of floors, ceilings and wall coverings, the construction of hearths, flues and fireplaces, and many other details too numerous to mention. The question, therefore, arises as to whether it is possible to encourage fire-resisting construction to a larger extent than is done at present. One difficulty already referred to is cost; a fire-resisting building is at present more costly to build, though with the more general use of fire-resisting materials the difference would no doubt rapidly decline—indeed, owing to the war, has already begun to decline. Take one instance: concrete, asbestos and other non-inflammable slabs have been largely employed in huts for walls and partitions all over the country, and with the present scarcity of timber are found cheaper and better.

The British Fire Prevention Committee does something in popularizing fire-resisting construction and materials. Its objects mainly are the conducting of investigations at its testing station, Regent's Park, of the fire-resisting qualities of building materials and the compiling of records and publishing the results of their tests. These reports are looked upon as constituting the leading authority on fire-prevention problems in the Empire. Those who support the committee by subscriptions include the Government and a number of public officials, various municipalities and some of the big industrial corporations. Traders, for obvious reasons, are debarred from membership. The claims of most fire-resisting materials have by now been through the ordeal by fire at Regent's Park testing station, the results are carefully noted and published without comment, and expressions of mere opinion are avoided. It is to be hoped that this work will, in the not distant future, be carried on with the closer co-operation of the State. It seems, therefore, that though self-interest, professional advice, demonstration and research have done something, so that everything possible for the prevention of fires in buildings which has yet been invented may be adopted, there are still many buildings so constructed that they only await the match to set them ablaze, though fortunately the regulations at present in force appear to be sufficient to prevent a conflagration on a really large scale. Nevertheless, there were in London alone from 1890 to 1900 ten large fires, not counting those which involved two or three houses only—one of the most serious being the Cripplegate fire in November, 1897. Streets were narrow, the fire easily

passed across them, and the damage was estimated at £1,250,000. It is to be regretted that this is one of the areas which have been rebuilt on the old lines, with the same narrow streets—though, I believe, concrete has been used in many instances in floors and roofs.

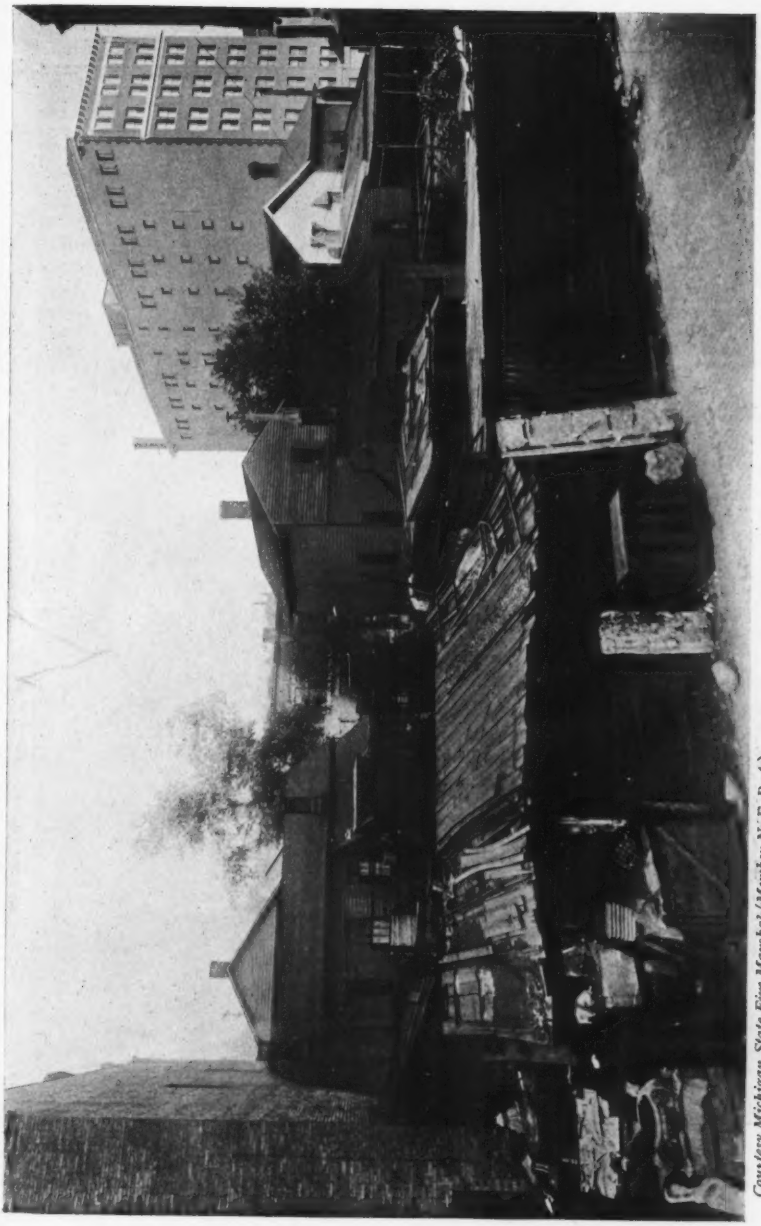
There appears only one further inducement that can be held out to the public to impel them to provide practical protection to their dwellings. The companies have a Fire Offices Committee, and I have read that special attractions in the way of reduced premiums are offered by the fire offices (whether tariff or non-tariff) to owners of buildings which are erected on fire-resisting principles, and also for buildings protected further by extinction appliances, fire alarms, etc. The scale of the rebates is not made public, but is issued confidentially to the various offices by the Committee. If this is correct, it seems to offer the very inducement we require; but the advantages offered need to be more generally known and understood before a building is erected—and not after, when it is too late. Perhaps this Committee could take us architects a little more into their confidence, so that we should know to some extent what their requirements are, to secure the rebates, while our plans are in course of preparation.

I will not venture further to elaborate this point, but at the same time I will ask you to believe that many of my colleagues, as well as myself, feel that we are getting behindhand in this matter of fire-resisting construction; and on looking around we think you are more able than any others to assist us—and that without any very drastic measures on your part—to obtain further good and sound building, and so modify the possibility of loss both to insurer and insured. The rules of the Fire Offices Committee have a standard of fire-resisting construction applicable to all buildings, except for a further standard for various types of mills. These rules follow generally the London Building Act requirements, and appear to be perfectly reasonable; but what advantages are given to buildings that come up to Standard 1? I am not clear. Some years ago, as a young man, I was erecting a warehouse which was to contain somewhat inflammable articles, and I recommended that the floors and roofs should be constructed of fire-resisting materials at additional cost. This was assented to on condition that the insurance premium was reduced. I made inquiries, and was courteously and frankly told that no concession could be made, and that my clients would no doubt use the concrete for their own safety. I firmly believe that my clients thought this meant that the companies had no faith in these expedients as a matter of protection; and the building was erected with the ordinary wood-joist floors. A few years afterwards it was burnt down. I had the pleasure of putting it up again and the companies the pleasure of paying for it—though there was no real gratification to any one concerned. I should like to take this opportunity of acknowledging how, both then and always, I have invariably found claims in which I have been concerned both courteously met and generously paid. In the above case, had those

concrete floors been put in, I am convinced the fire would have been localized and minimized.

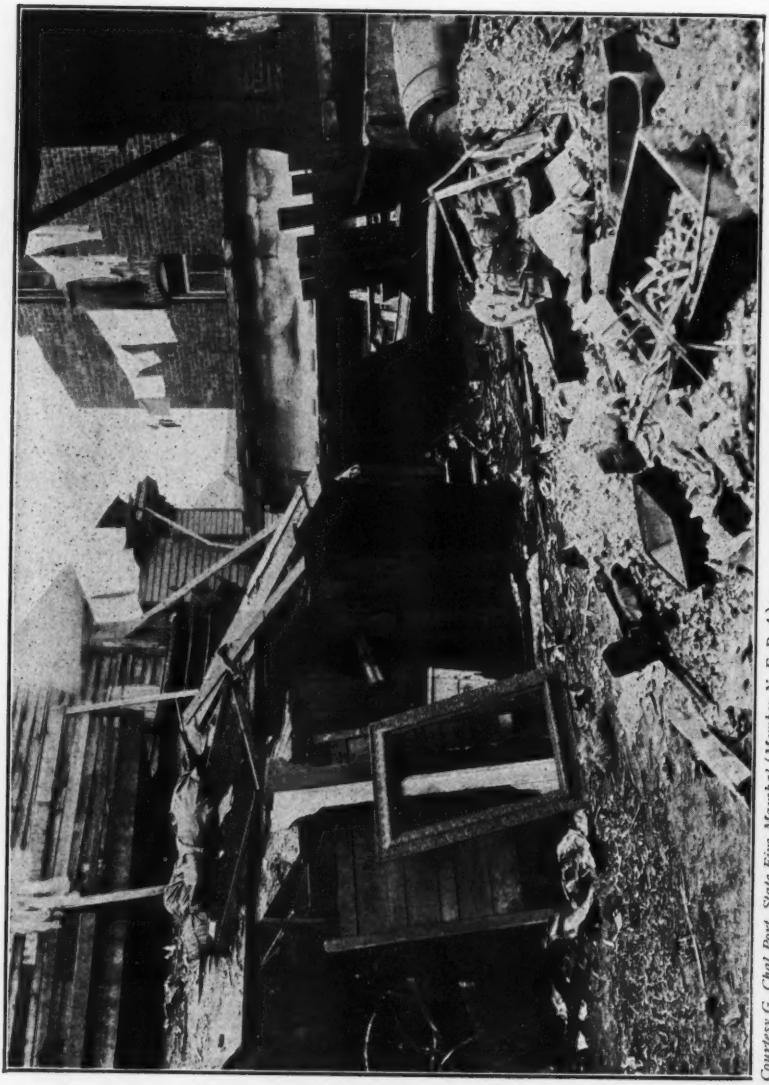
The United States of America, which have suffered so severely from vast conflagrations, such as Chicago, Boston, and San Francisco, have benefited by their lesson, and are using fire-resisting materials wherever possible; and not only that, but they are laying out their buildings on large and simple lines, and no one who has been across the Atlantic during the last few years can fail to have been struck by the great advances, both in the laying out of towns and in the scientific construction and design of buildings. The system of insurance in America is different from ours, but its beneficial influence on the better construction and arrangement of the buildings is the same. The chief insurance offices are monumental buildings, with great halls of most imposing character, well calculated to impress those who use them with the dignity and importance of their profession. Here in England, too, I should like to bear testimony to the good influence insurance companies have exercised in the buildings they have had erected for their own use. The City of London has streets of palaces, many of the finest of them insurance offices. Unfortunately, the streets themselves are so narrow and crowded that it is difficult to see the buildings; but a walk through the city on a Sunday morning is a revelation, and a finer range of commercial edifices, architecturally, can hardly be found anywhere else in the world. A friend of mine, taking such a Sunday walk through the city one morning, came across Lord Leighton, who was at that time president of the Royal Academy, and found him gazing at an insurance office building of singular refinement designed by an architect long since dead; and Leighton told my friend he occasionally came into the city on a Sunday morning in that way in order to refresh his senses with a study of this building.

But it is not in the City of London only that the insurance offices have set so fine an example in their buildings; in every city and in every town of importance throughout the Kingdom the finest buildings in the principal streets will usually be the bank and the insurance office, relieving the thoroughfare very often from a deadly and depressing dulness. It is for these and other benefits that we architects recognize so fully what we owe to insurance, and why we always venture to hope that by a little more co-operation in the future buildings may be still more influenced by insurance, so as to resist fires and save loss, to the great advantage of those who insure and of those who are insured.



Courtesy Michigan State Fire Marshal (Member N. F. P. A.)

Old shacks at Grand Rapids, Michigan, ordered removed by the State Fire Marshal.



Courtesy G. Chal Port, State Fire Marshal (Member N. F. P. A.)

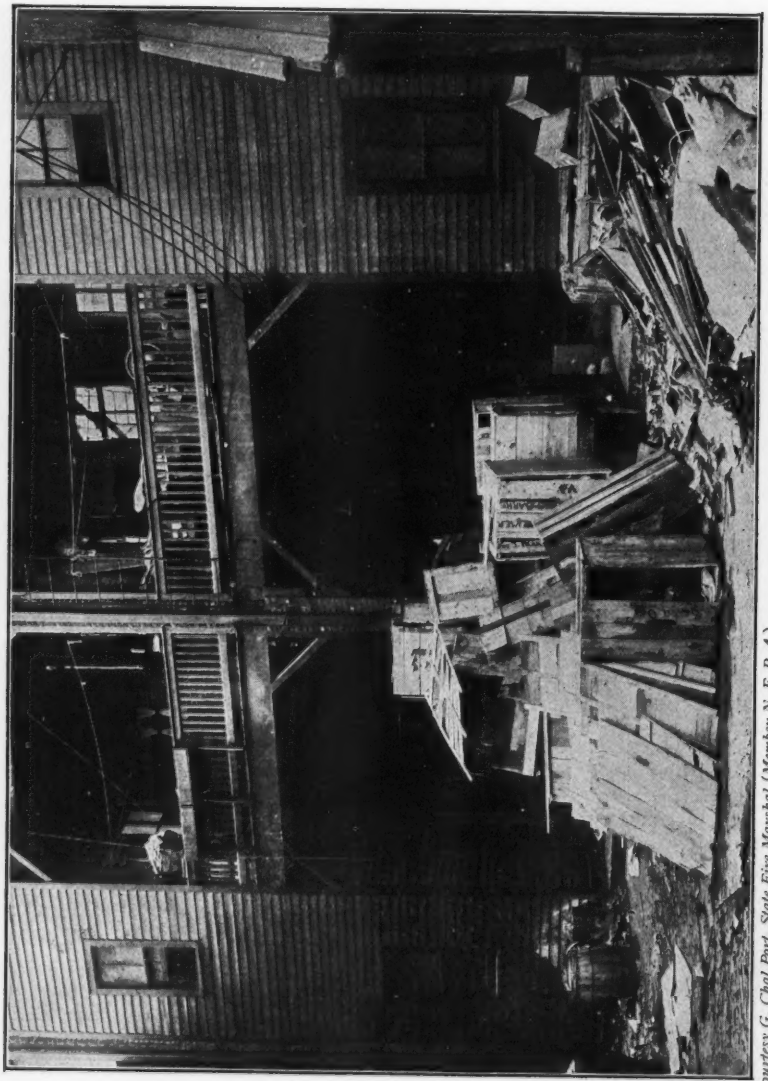
Dangerous fire hazard in the rear of a restaurant at Wilkes-Barre, Pa.

Courtesy G. Chal Port, State Fire Marshal (Member N. F. P. A.)

Dangerous fire hazard in the rear of a restaurant at Wilkes-Barre, Pa.

Courtesy G. Chal Port, State Fire Marshal (Member N. F. P. A.)

Sanitary and fire hazard in the rear of a fish market at Wilkes-Barre, Pa.



Courtesy G. Chal Port, State Fire Marshal (Member N. F. P. A.)

Fire hazard found by Fire Marshal in the rear of clothing store and tenement house at Wilkes-Barre, Pa.

Courtesy G. Chal Port, State Fire Marshal (Member N. F. P. A.)

Dangerous conditions found by Fire Marshal in the rear of two millinery stores at Wilkes-Barre, Pa. Note ashes piled against building.

The Teaching of Fire Protection in Architectural Schools.

That those who have reached the top of the ladder in the architectural profession have no lack of enthusiasm for the study of fire protection has been made manifest by the activities of the Committee on Fire Prevention of the American Institute of Architects, the attention given to the subject in the Structural Service Department of the *Journal* of the Institute, and the devoted service rendered by distinguished members of the Institute, both as officers and members of committees of the N. F. P. A. It was not, however, apparent to what extent the importance of keeping fire hazards and their elimination always in mind was being impressed upon the students in the architectural schools; and for the purpose of obtaining information on this point inquiries were addressed to the eleven architectural schools whose graduates are accepted without further examination by the American Institute. A summary of the replies received is given below:—

University of California. A course on Fireproofing is given in the department of Civil Engineering. This course covers "the resistance of building materials to fire; fire-resistive and slow burning construction; fire extinguishing equipment; corrosion and preservation of structural metal." Many of our readers will recollect that a more detailed account of this "Fireproofing Course" was published in the *Quarterly* of July, 1914 (Vol. VIII, No. 1, page 19), to which reference may profitably be made in this connection.

Carnegie Institute of Technology, Pittsburgh. In connection with the courses in architectural construction, "instruction of a general nature as to methods of fireproofing in buildings" is given to the students. There are no separate courses on the subject of fire protection and prevention.

Columbia University. Information on the subject of fire protection and prevention is given in a course in Building Materials and Construction required of all students during their second year. The instruction includes:—(1) "An explanation of how ordinary non-fireproof buildings may be made safer against fire by the use of beam filling, fire stops in partitions, approved methods of framing around fireplaces, chimneys, flues, etc." (2) "An explanation of the principles of slow burning or mill construction and their application to domestic architecture. (3) "An explanation of the different methods of making construction fireproof by the use of terra cotta,

hollow tile, reinforced concrete, etc., the advantages and disadvantages of each and under what circumstances each should be used."

Cornell University. Prior to 1900 instruction in fire prevention and fire protection was given as part of the courses in general construction. In that year the courses were reorganized and one of them designated as "Steel Construction and Fireproofing." Further subdivisions have since been made, and for a number of years one course of fifteen or sixteen lectures has been "wholly devoted to the question of fire-resisting design and fire protection." The teachers of architectural design, structural design and structural details are all sympathetic, and it is believed that fairly good care is taken of the fire protection aspects in all departments.

Harvard University. In the course on "Materials and Methods of Building Construction," attention is given to the following among other subjects:—Structural terra cotta, slow-burning construction, fire losses and precautions to be taken in planning and arrangement of a building for safety to life and property, fire-stopping, terra cotta floor arches, terra cotta and gypsum block partitions, reinforced concrete, fire-resisting finish and fire protection equipment, besides incidental mention of the effect of fire on various materials when considering them. "On trips to buildings, the students' attention is called to matters of fireproofing, and important fires are commented upon as they occur."

For information regarding the Fire Protection Engineering Course at Harvard University, members are referred to the article bearing that title in the *Quarterly* of April, 1914 (Vol. VII, No. 4, page 389).

University of Illinois. There is "no thoroughly well-defined course in fireproofing," but this subject has recently been incorporated in one of the regular courses, and about six weeks devoted to it. In this work the endeavor is made to "point out the necessity of ample fire protection for structural features of the building" by the use of the Building Code of the National Board of Fire Underwriters and certain city ordinances indicating the minimum requirements along this line. Each year the seniors of the Department of Architecture are taken on a visit of instruction to the Underwriters' Laboratories. The preparation of a course "which will deal with the subject of fire protection in a very thorough manner" is under consideration.

University of Michigan. Fire prevention and protection are taken up in connection with the courses in building construction, "in which connection a great deal of information regarding these subjects is given the students." "Lantern slides of buildings which have burned are used to show actual effect of fire. Depreciation of buildings from other causes is also gone into."

University of Pennsylvania. All candidates for a degree are required to take "a course of lectures given one hour a week for one year on the materials and methods of masonry construction.

This course includes a chapter on Fireproof Construction in Buildings." "The attention of the students is often called to the subject of fire protection and fire prevention in connection with some of their other courses." The matter also receives notice in a fourth-year optional course in architectural engineering.

Syracuse University. There are "no organized courses as such on fire protection and prevention," but these subjects are included, as far as possible, in other courses.

Massachusetts Institute of Technology. No definite course is given to the students on fire protection. "They have more or less instruction in this subject, however, in the course in Office Practice and in the course in Constructive Design." An occasional special lecture has also been delivered by a member of the Faculty dealing directly with fire protection.

Washington University, St. Louis. At the time inquiry was made the course in Materials and Construction was being entirely re-outlined. The first part of the course was "essentially devoted to the study of materials," and the second part "to their application in construction." The instructor put "a great deal of stress upon fire-proof materials," and intended to devote several lectures to the subject of fire protection.

It is also of interest to note that a course on fire protection, "consisting of two lectures per week in the senior year, second semester, of the course in Architectural Engineering" is included in the curriculum of the Department of Architecture of the State University of Ohio. The subjects covered largely follow the chapters of Freitag's "Fire Prevention and Fire Protection," which is used as a text-book. Particular stress is laid on the annual fire waste, the work of the National Board of Fire Underwriters and the National Fire Protection Association, the various types of fire-resistive construction, door and window protection, and sprinkler systems.

Sprinkler Equipments in Halifax Explosion.

The accompanying diagram and notes, made immediately after the great explosion in Halifax in December last, are reproduced by courtesy of the Nova Scotia Board of Fire Underwriters. The numbers in the notes correspond with those on the diagram. In the latter the Dartmouth side of the water is not drawn to scale.

No. 1. This plant was completely demolished, there being nothing left now but the ruins, and on top of the pan house was a 5000-gallon wood tank.

No. 2. This plant consists of a group of buildings mostly frame. All windows were blown in and roofs badly damaged, putting the entire equipment out of commission. Supplies to the equipment were a 6-inch connection from the city mains and a 30,000-gallon wood tank on a 75-foot steel lattice tower, which came through the explosion without any damage.

No. 3. This is a four-story brick mill construction building with a detached boiler house. The explosion broke in the roof, breaking off the sprinkler piping in certain parts, which necessitated the shutting off of supplies. Soon after a fire broke out in a dwelling some 150 feet away, and the sparks from this dwelling flew in at the window openings, which had been broken by the explosion, and the fire got out of control, resulting in a total loss. The supplies to this equipment were a steam fire pump and a 40,000-gallon steel tank on a 100-foot tower. The only damage to the tank was that the tank boxing was entirely burned off and the riser badly twisted.

No. 4. This property is located on the water front, and is mostly of frame construction. A shed extending out on the wharf was badly damaged by the explosion. The walls bulged out and the roof collapsed. This shed had in it 95 heads, and all piping has now been removed until such time as the shed is reconstructed. Supplies to this equipment were connections from the city main and a 40,000-gallon wood gravity tank on a 75-foot steel lattice tower, neither of which received any damage through the explosion.

No. 5. This is a three-story brick joist constructed building, and the equipment was not damaged in any way through the explosion. The secondary supply to this equipment is a 20,000-gallon wood gravity tank on a 20-foot steel tower, which rests on 16-inch brick walls, and at the time of erection there was some doubt as to the ability of these walls to carry the load. The tank and tower were not, however, damaged in any way.

No. 6. This is a four-story brick joist constructed building with a wet pipe sprinkler system, supply from city mains and a 30,000-gallon wood gravity tank on a 75-foot steel angle tower. The tank was not in any way damaged, but on account of the windows being blown out the heating system froze up, and the tank had to be drained, but the draining of the sprinkler system was overlooked during the excitement, and consequently it was badly frozen.

No. 7. This is a six-story brick building, equipped with wet pipe sprinklers, with a supply from city mains and two pressure tanks, and although at the time of the explosion the air suddenly left both tanks, they do not seem to be in any way damaged, and the proper protection has now been restored.

Nos. 8 and 9. These comprise a three and four-story brick and frame building and a three-story brick building adjoining each other, the sprinkler

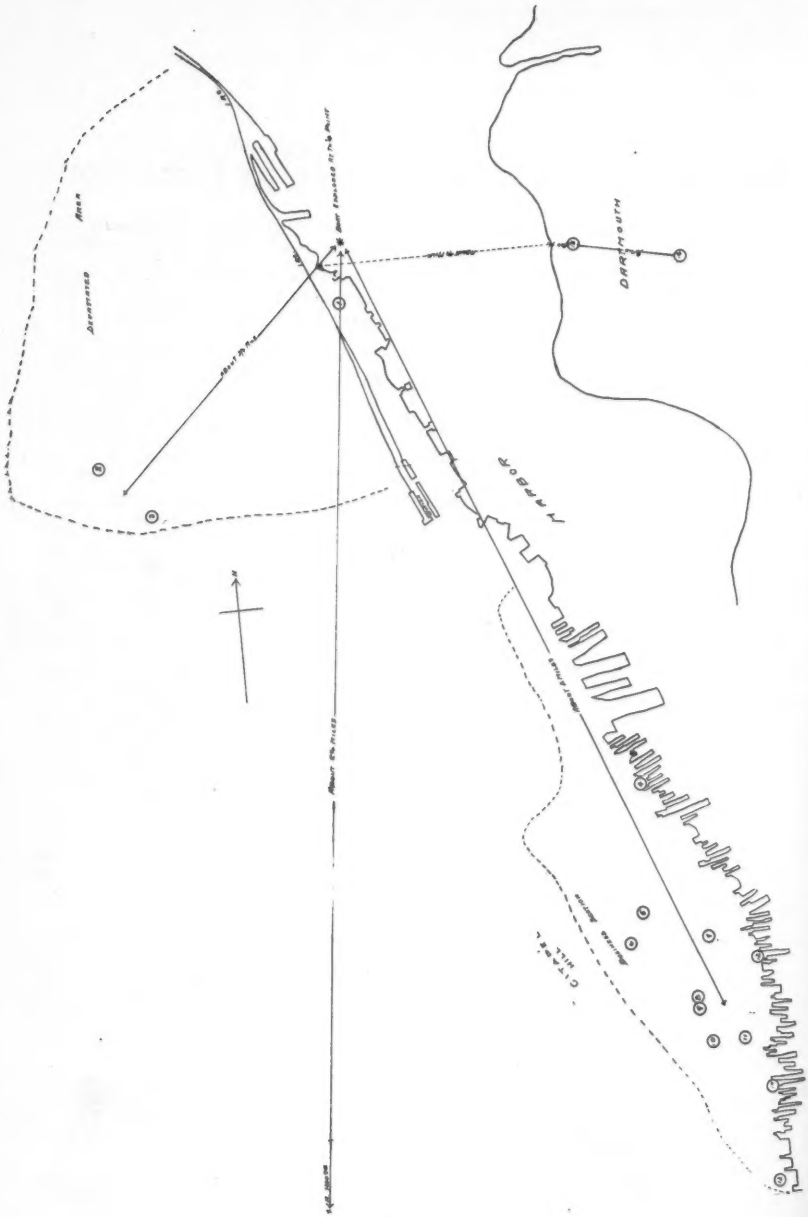


Diagram showing Location of Sprinkler Tanks at Halifax, N. S.

equipment being a wet pipe system fed from the city supply and pressure tanks in the first-mentioned. The equipment was not in any way damaged.

No. 10. This equipment, including a 4,000-gallon wood gravity tank resting on I-beams on walls, was not in any way damaged.

No. 11. This is a one to four-story brick building protected by a dry pipe system supplied from city mains and a 30,000-gallon wood gravity tank on 75-foot steel lattice tower. The gravity tank was not damaged, and the damage to the equipment amounted to three sprinkler heads being broken off when two skylights in the one-story section fell in.

No. 12. This risk is protected by wet and dry pipe systems, supplied from city mains and a 40,000-gallon wood gravity tank on a 75-foot steel lattice tower. Gravity tank was not damaged, and the injuries to the equipment consisted of one floor of one section being put out of commission by the collapsing of the roof.

Nos. 13 and 14. Understand that the large sheet-iron rolling doors in front of the car barn blew in, tearing down parts of the equipment, after which the systems were not properly drained, same being badly frozen. Supplies to the No. 13 equipment were city mains and fire pump, with no gravity tank, but the secondary supply to No. 14 equipment is a 40,000-gallon wood tank on a 75-foot steel angle tower, which was not injured in any way, but the sprinkler equipment was badly frozen on account of some of the roofs falling in and breaking off the sprinkler piping and tripping the valves, after which same did not receive proper attention.

No. 15. A one-story small frame foundry equipped with dry pipe sprinklers, supplies from city mains only. This property was completely demolished.

No. 16. This property consists of a large group of buildings mostly of frame construction, equipped with wet and dry pipe sprinklers, supplies being from two fire pumps and a 15,000-gallon wood gravity tank on a 75-foot pipe tower. Practically every building was damaged by the explosion, and all sprinkler piping will have to be taken down. Equipment did not receive proper attention after the explosion, and so far as is known at present, a lot of piping containing water froze, also six old style dry pipe valves, which were badly split, also one 6-inch alarm valve, and more damage may be found when the appliances have been inspected. The gravity tank was not in any way damaged, but had to be drained, consequently the entire equipment is now out of commission.

As the member through whose thoughtfulness this material has been made available to the QUARTERLY remarks, the experiences here recorded are of particular interest when we remember the hue and cry often made on the subject of danger from sprinkler tanks.

Diagram showing Location of Sprinkler Tanks at Halifax, N. S.

Flow Capacity of Water Pipes.

By C. F. Wagner

Engineer, Oregon Insurance Rating Bureau.
(Member N. F. P. A.)

In designing fire protection water mains it is essential to know the flowing capacity of pipes. There are a great many theoretical formulæ for determining the flow, but these formulæ do not all check with actual flow tests, and do not all check with each other. They usually contain a number of variable factors, and are difficult to apply. The Williams and Hazen formula has been developed from the results of a number of tests and is based upon actual rather than theoretical conditions. This formula has in the past few years been used by a great many engineers.

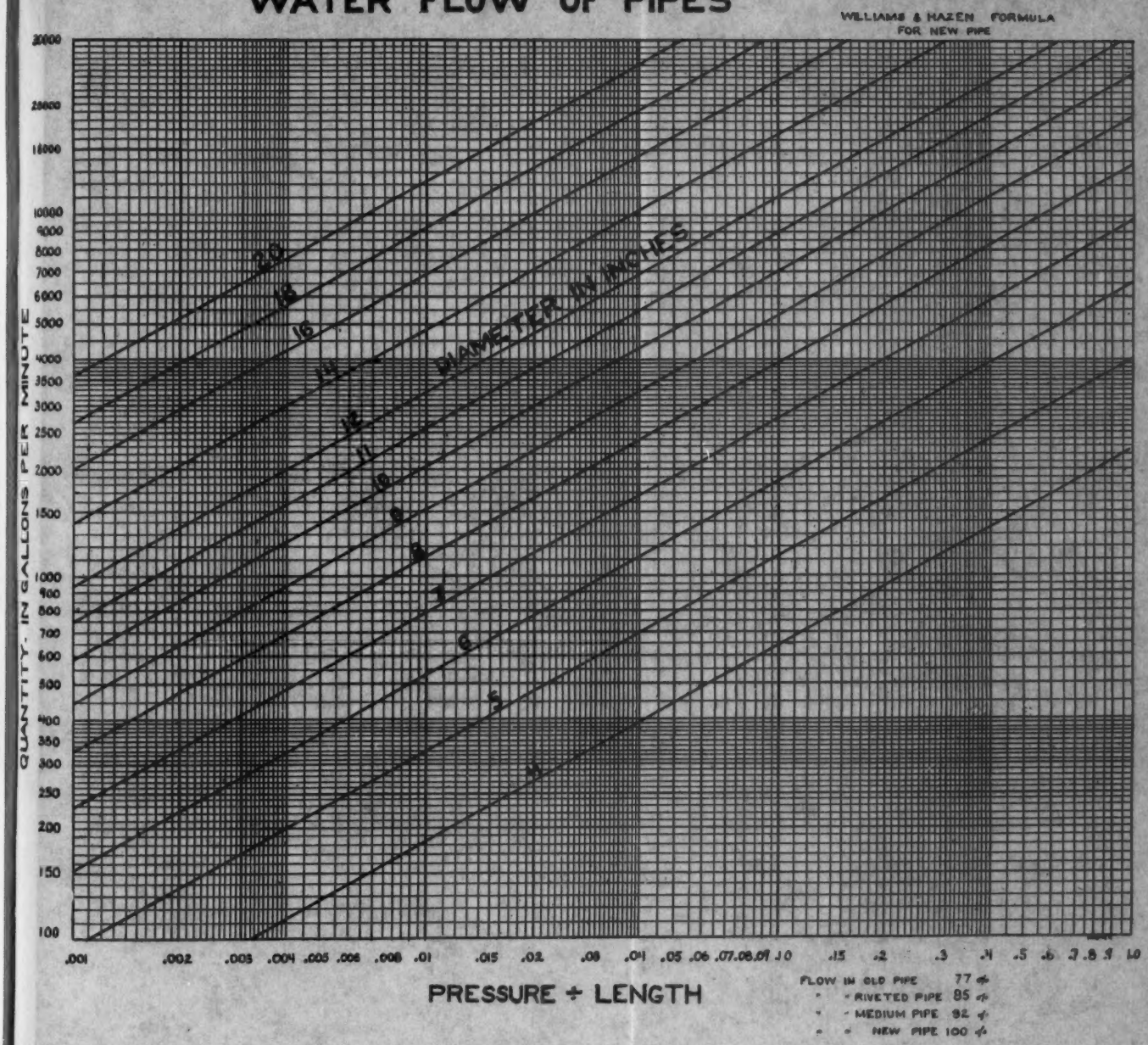
The accompanying straight line diagram has been developed from this formula for conditions met in fire protection. With most formulæ capacity is expressed in cubic feet per second, and pressure is expressed in head in feet. These terms are seldom used in expressing fire protection terms, so capacity in gallons per minute and pressure in pounds per square inch are used on the diagram.

In using formulæ or diagrams for the computation of water flow, care should be taken to have an understanding of the term pressure. Static pressure is the pressure caused by the difference in elevation between the intake and the point where pressure is taken. This pressure is independent of the size of the pipe or length of pipe. The flowing pressure is the pressure in a pipe while water is flowing, and is affected by the length of pipe, kind of pipe, size of pipe, and the amount of water flowing. This is really a working pressure and is what we are concerned with in fire protection.

In text-books it is customary to speak of capacity of pipe lines as meaning the maximum capacity in which the drop in pressure at the discharge point is from static pressure to zero pressure. In fire protection designing it is customary to want a reserve flowing pressure to force good distribution from sprinklers or to give a good throw to a hydrant stream. In each case it is the loss of pressure that is doing the work, but in the case of the wide open pipe, the loss in pressure is equal to the static pressure, whereas in the case of a reserve flowing pressure, the loss in pressure is not the static pressure. Care must be taken in knowing what is meant by pressure.

If there is a pressure of 80 pounds per square inch at the end of the pipe and the pipe is fully opened, the pressure at the open end will drop to zero and the drop in pressure, 80 pounds, is producing the maximum flow. If a hydrant is at the end of the pipe and it is desired to retain a pressure of 50 pounds at the hydrant for a direct hose stream, the drop in pressure, 30 pounds, is what produces the flow.

WATER FLOW OF PIPES



In using the diagram or formula the drop in pressure should be used. As an example of the use of the diagram, the following are given:

To Determine Capacity:

Assume the length of the pipe is 1,600 feet, size of pipe is 6 inches, static pressure at the hydrant 85 pounds. It is determined that 60 pounds pressure is necessary at the hydrant to properly throw water on the buildings to be protected. Under these conditions it is wanted to know how much water will be available at the hydrant. The loss in pressure divided by length ($25 \div 1600$) $= .0156$. This line on the diagram is extended vertically to where it intersects the 6-inch pipe line. The horizontal line through the point of intersection represents the capacity of 680 gallons per minute.

To Determine Diameter of Pipes:

Assume that a reservoir is 8,000 feet from a plant and it is desired to have a capacity of 1,800 gallons per minute with the flowing pressure at the plant of at least 50 pounds per square inch. The static pressure is 80 pounds. What size of pipe will be necessary to supply the water under these conditions. The loss in pressure (80-50) is 30 pounds, and this divided by length equals .00375. The intersection of the .00375 pressure and length line with the 2,000 capacity line represents a diameter of 12 inches.

To Determine Pressure:

In this case a pump discharges into an 8-inch pipe line. A hydrant located 2,000 feet from the plant will be used to supply three streams or 750 gallons per minute, and it is desired to maintain a flowing pressure of 60 pounds at the hydrant under these conditions. What pressure should be maintained at the pump? The intersection of the 750 gallon line with the 8-inch pipe line on the diagram gives a pressure length reading of .0045. Therefore the loss in pressure divided by length is equal to .0045, from which it is computed by simple arithmetic the loss in pressure is 9 pounds. Therefore, if it is desired to maintain a pressure of 60 pounds at the hydrant, a pressure of 69 pounds must be maintained at the pump.

When the variables, such as pressure, capacity, size of pipe, and length of pipe are known, conditions which disturb the equations frequently remain. The roughness of pipe, condition of joints, condition of sediment and other factors frequently make computed performance differ from actual test performance. It is almost impossible to accurately use formulæ in computing diagrams on other than clean pipe. When modifying factors are used, they are either assumed or determined by test upon the pipe in question.

The Grain Elevator as Source of Fires and Explosions.

By B. W. Dedrick,

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Courtesy of The Operative Miller.

Elevators, particularly the heads, have been in the past prolific sources of fire. The old-style elevator head, with the straight-across bottom, just a half-inch or so under the lower side of pulley, was especially dangerous, because it was a gathering place for dust, the face of pulley actually touching and turning in this compact dust. Many mills and elevators have been destroyed in that way, and undoubtedly many of the mysterious fires and explosions had their origin in the elevator heads. It is possible also that by a displacement of a leg the belt may rub or bear continuously against one side of a leg for a considerable distance and eventually cause a fire. Other sources of fire are the belt rubbing at the boot, the pulley bearing against the boot, the bearing running dry and igniting the wooden side of boot, or starting a fire by means of gathered dust.

It is probable that in eight out of every ten fires that have their origin in elevators the source or point of origin is the head. There are various causes. There may be a single cause or factor or a combination of causes which starts the blaze.

Elevators handling grain are particularly susceptible and dangerous as sources of fire: the grain dust which gathers in the heads at any point where it can lodge becomes very light, powdery and dry, and, being rather loose or free in character, readily ignites, and, if in any bulk, will burn at the first like punk, or tinder. If there is any current of air to fan it, it burns very rapidly and soon becomes a mass of live coals, either setting fire to the wood in contact with it or finally bursting into a flame itself.

Often the fire starts some hours after the elevator ceases to run, apparently lying dormant or smoldering until sufficient heat is generated to start the blaze, or a fire is started at the boot by some coals or burning dust dropping down the leg.

Cases have occurred where fires started simultaneously at the top and bottom, or, rather, in attic and basement of mills and elevators.

If the elevator shaft is out of level or line, it may cause the pulley to rub against the sides of the head, and, of course, the belt also, and the shaft may bear and make a seat for itself on the bottom or side of a hole in the head.

The holes in the head through which the shaft passes are frequently but little larger than the shaft, leaving a scant margin of opening around the shaft, and, should the bearings become sufficiently worn, the shaft will rest and turn against a dry surface, and while elevator shafts turn slowly, yet the constant weight, sometimes considerable, and the friction kept up unceasingly for days at a time ultimately generate sufficient heat to char or set fire to the woodwork, or, perchance, dust adjacent to the shaft. Another cause is the settling down of the elevator and bringing the head to bear on the shaft. This may be caused by the settlement of some lower floor upon which the bottom or boot of the elevator rests, or by a sagging of a floor or support under some particular elevator or certain elevators in the line, as in a mill, the others being unaffected.

The settlement may be permanent or variable, caused by the alteration of floors due to the intermittent loading and unloading of bins, and to the storage of flour, bags of wheat or other material on the floors.

Again, if the elevators rest on a good solid basement floor, they will stand solid and not settle. It may then be the elevator shaft that comes down with the gradual settlement of the building or floor that carries or supports the bearings. If the elevator is not plumb, the belt is sure to rub along one of the sides.

The upper part of a section of the elevator head may become displaced or cocked over to one side, thus allowing the pulley to bear or run against some portion of the head.

Improper speeds or defective discharge are sources of danger because of the liability of clogging down the elevator, and also because of blowing of dust, which may be sufficient to cause an explosion on contact with an open light, or even sparks generated by static electricity. When an elevator becomes clogged and chokes down, it is only a question of time when a fire will be started, unless the trouble is relieved, or the machinery stopped before the danger point is reached.

When the elevator chokes down or the belt is stopped by reason of something getting into the elevator and lodging at the bottom of the boot and wedging between bucket and bottom, or a bucket gets bent out, or becomes loosened and digs into the bottom or sides of the elevator, the pulley, if there is sufficient power, keeps turning and the friction evolved by the pulley turning against the stationary belt, soon generates sufficient heat to make the pulley and belt unbearable to the hand. If this continues running for any length of time the belt is likely to be burnt in two and to set fire to the head and any dust gathered within the head. The belt then gives way, and both ends drop back and down the legs for a certain distance and jam. The burning ends drop sparks down the legs to the bottom and also afford the means of starting fire at the points where the ends lodge. The clinging dust within the elevator, thus disturbed and set free, may explode.

It is bad practice to open up the door or lid of an elevator (more particularly if carrying floury material) that is clogged at the head,

with the stock going down the back leg, because, in addition to causing blowing, the buckets are overloaded and carry up the material much like a chain pump, and at the point of the open door spill or shoot out the stock onto the floor, usually three or four feet below, causing a great dust to arise and float and spread throughout the mill, and if there is an open light or a lantern in the vicinity, explosion and fire are almost certain to result. The explosion may not be very serious and may be confined to a limited area, and do no particular damage; but on the other hand, if the conditions or elements are just right, it may be very disastrous, as the first or primary explosion may be powerful enough to jar down dust lodged on that floor or other parts of the building, and cause a secondary explosion, the blast of which wrecks the building and snuffs out the lives of the workmen.

A number of elevators may be strung along or nested between two bearings rather far apart. It sometimes happens that a shaft is not large or stiff enough to resist springing or bending because of the weight of the pulleys and the strain put upon the shaft by the tightening of the elevator belts and the loads which they carry. The result is that the shaft bears in the holes in the elevator head, particularly in those situated near the center between the two bearings.

The shaft often becomes very hot and will start a fire. Moreover, while it is possible for one or two elevators in the center of the line to run fairly well, that is, the belt running full upon the pulley, the belts of the elevators on either side of the center will run more or less to one side of the pulley in the direction of the spring or bend, and rub against the head. This can be easily remedied by placing a bearing in the center, between two contiguous elevators, using the elevators themselves as the supports. The writer has made use of maple blocks for such a bearing, which answered the purpose admirably, as frequently the space was so contracted that an ordinary iron boxbearing could not be used. The elevator belts were loosened, allowing the shaft to spring back in place, which was then leveled. Cross pieces were fastened to the elevators, and then strips under these reaching down and bearing on the floor nailed to the leg as additional supports. The bearing was mounted on a small beam supported by the cross pieces. This is a method that could be adopted in which all the bearings of an elevator line shaft could be mounted and supported, making the elevator and its shaft self-contained, with the possible exception of the drive end bearing, which, however, could be mounted on posts supported by the same floor. The upper or attic floor, which contains the heads of the line of elevators, is generally free of any heavy machinery or carrying loads subject to change, as there are no bins to be filled or drawn from; hence the load is constant, and not like the floor below, or others below this that perhaps carry bins and other loads that are continuously changing except, of course, in the modern constructed concrete mill or elevator building.

The line of elevators including the shaft, being carried and supported by the upper floor would not be subject to the alteration or settlement of the lower floors, which may vary more or less in different parts or bays, affected by changing bin loads or other forms of storage, in that quarter.

Each elevator should be carried by the floor by nailing or screwing strips or cleats eight or nine inches long and of the same width as the legs to both the front or ascending leg and the back or descending leg, on both the rear and front of each leg. The lower end of these cleats or supporting strips would rest upon the floor, the upper end being nicely beveled. These strips may be an inch thick for the ordinary size elevator, and rest on a reinforcing plate or strip laid on the floor and along the line of the elevator to give greater supporting force and to distribute the load more evenly should the floor be for any reason weak at the ends next to the elevator.

The legs extending down and through the lower floors should have a slight clearance all around them at the floor line so as not to be pinched and affected by any movement of these floors.

The boots landing on any of these floors should, if carried down to the floor line, not rest on the floor, but have some clearance, more particularly if this floor is subject to changes.

It would be better practice to have every elevator boot that must come down near the floor placed so that the bottom is at least six inches above the floor, if for no other reason than that it is more clean, sanitary and economical. In case of a choke-up, necessitating relief by drawing the slides in the boot, stock can be caught in a box made for the purpose and no loss or litter ensue; besides the stock is thus kept clean, and all can be utilized, whereas, if it is picked up from the floor, some loss is sure to occur, because, after picking up the bulk and skimming down to the floor, the remainder, even if brushed up carefully, is apt to be contaminated by floor litter or dust, and will perhaps be thrown into the feed pile.

Elevators that extend down to the basement should at least have the boot some distance from the floor for this reason. The boots can be, if it is the intention to have the basement floor as the landing for the elevator line, supported on a stout frame or truss that rests on the floor, the legs of this frame so disposed as not to interfere with the sliding of a box under the elevator boot in case of a choke-up, and its relief at the bottom. This keeps the bottom of boots and any stock therein free from dampness and must.

The basement floor, especially if of brick or concrete, will afford a solid and unchanging support for the elevator line, providing the legs are clear of all other floors. However, the shaft may be susceptible of changes due to the settlement of the walls or the supporting floor, and in time causes trouble.

It is hardly necessary to suggest the remedies, for the pointing out of these dangers and their causes thus known, are themselves suggestive of their application. If there is trouble, find the cause, then remedy it. Don't procrastinate.* We are having altogether too many fires and explosions in mills, cereal plants and elevators.

* There have been many grain elevators, mills and warehouses destroyed in the past year by fires and explosions under circumstances warranting the conclusion that they were not caused by or the result of accident or neglect, but by design on the part of persons influenced by German propaganda to prevent our sending over grain, flour and food to our Allies on the other side, or to cripple our own resources; hence, the need of all the more watchfulness in the care and operation of the plants, and guarding them from destruction by incendiarism, as well as the fires caused by faulty construction, machinery or negligence.

Although these are abnormal times, and the mills and elevators are in many instances rushed, there should be no let-up on the exercise of vigilance and great care on the part of those operating elevators, mills and cereal plants, and when there are certain troubles or evils known to exist in connection with elevators, as has been pointed out, investigate, then get busy.

The oiling of elevator shaft bearings is often neglected, because, as a rule, the bearings are not easily accessible, it being perhaps necessary to climb a ladder, and, as the shafts are run very slowly compared to some of the other machines, the operative or oiler, is apt to think that there is no particular harm if they are not oiled every day, and to let them go for a week or two at a time, and sometimes longer. This remark only applies to the old-fashioned plain babbit or wooden bearing, and not the self-oiling types, which require only periodical oiling or renewal of the oil in the reservoir. But these, too, are often neglected. The elevator shaft, or rather bearing, can become very warm, even hot, if run dry continuously for a long time.

The heads and bearings of elevators ought to be easy of access, so that they will not be neglected or overlooked, as is apt to be the case when they are difficult, even dangerous, of access.

A gallery or running board should be provided and placed on the discharge side of the elevator at the head, and a hand rail attached. This should be reached by a ladder or step. This floor or gallery provides not only the means of reaching and oiling the bearing, but of readily examining the head and interior, and for easier work in case of relieving a choke. Sometimes strings pile up on the tongue above the throat and interfere with a free discharge and some material drops down the back leg, causing more or less "blowing" and dust to issue from elevator or connecting spout.

Easy access to the head of any elevator, or in fact any machine, invites frequent inspection, and investigation and correction when things go wrong.

The journals at the boot of elevator are perhaps the most neglected of any bearings in a mill, so far as regular oiling is concerned. Sometimes the boots are so close together that it is very difficult, if not impossible, to oil them in the ordinary way; the holes, too, get plugged with dirt, and the oiler passes by with the intention of oiling them some other time; this "time" finally running into weeks or months, perhaps a year, before they get a drop of oil.

Fire Prevention and Fire Protection During Construction.

With Notes on Construction of Fire Cut-offs and Installation of Fire Extinguishing Equipment.

By H. L. Miner

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The possibility of loss by fire during the construction period is seldom appreciated. Practically every class of construction work, however, requires the use of inflammable materials in conjunction with substances, processes, devices or equipment which introduce fire hazard.

Fire protection, if any, is usually incomplete and cannot be relied upon for service in event of fire.

A number of serious fires have occurred in buildings under construction, one of the most recent having taken place in a reinforced concrete building in New England. The building was five stories high and approximately 17,000 square feet in area. The fire started in a waste material chute from a carelessly discarded match or cigarette butt. It spread to combustible storage in the building, and the structure was badly damaged before the fire was extinguished by the city fire department.

Another striking example recently occurred in one of our large Eastern cities. Due to the usual congestion during the construction stage of an extensive project and lack of knowledge or negligence on the part of those responsible, a fire which was of the preventable type caused a very heavy loss, approximately $400,000. The investigators reported that the fire was caused by "gross carelessness on the part of the contractors." It was further "reported that the negligence was so flagrant as to justify institution of civil proceedings—to recover for the damage."

Entirely apart, however, from the actual monetary loss, it is at this time particularly essential that fire be prevented, because of the high cost of and difficulty in obtaining construction materials, scarcity of labor, coupled with the vital need of conserving both labor and material, and the absolute necessity that certain construction work be completed at the earliest possible moment. Delay may mean inconceivable disaster. This imposes upon all of us the task to do everything in our power to prevent fires, which always cause irreplaceable loss, but at this time a far greater disaster—delay.

It is, therefore, the object of this article to briefly present to the construction engineer steps which should be taken to reduce the probability of a fire to a minimum and to bring to his attention some of the most common fire hazards which are usually present during construction. The storage of lumber, location and arrangement of storage sheds and shops, provision of temporary fire fighting equipment, and other phases of fire prevention and protection usually overlooked on work of this character, will be touched upon. It is impossible to cover all hazards or conditions which the construction engineer will meet with on a large project. However, a study of those presented in this article will indicate that the hazards which may be introduced by devices or materials should be analyzed, as well as the work for which they are intended.

PART I.

Storage of Raw Materials and Temporary Construction Buildings.

One of the first problems confronting the construction engineer is the storage of raw materials, the provision of storage sheds, construction shops, offices and other buildings necessary for handling the different classes of work.

The raw materials can be divided into two general classes: viz., those which can be stored unprotected against weather in the open, such as structural steel, pipe, lumber, brick, gravel, etc., and those which, due to value or susceptibility to water damage, must be protected in store houses. This latter class includes tools, fittings, copper, cement, lime and similar materials.

In selecting sites, both for outside storage shops or other buildings, the need of having them accessible to the work, and at the same time so located or separated that they do not unduly expose the construction work, or each other, should be kept in mind.

Storage of Lumber.

Wood in some form enters into practically every type of construction, and usually introduces the largest amount of the combustible material. The location of the lumber storage yard needs careful consideration.

It should be at a detached location. The lumber piles should have several feet space between them and the rows of piles should be separated by at least 10 feet of clear space, and preferably 20 feet. Where space will permit, not over 1,000,000 board feet should be stored at one location. In arranging large storages in separate fire areas, care should be taken not to have all lumber of one dimension in an area. The destruction of one area under these conditions might seriously handicap the work.

The ground between the piles should be kept free of combustible materials, such as dry vegetation, bark, chips, paper, etc., to prevent fire spreading from one pile to another through this medium. This also reduces the ember hazard.

Unless absolutely necessary, the piles should not be higher than 10 to 15 feet above the ground. For fire protection, see caption "Fire Protection."

Storage Sheds.

These should be located at a point where they will be convenient to operations, but will not form a serious exposure to the buildings under construction. They should be built in small units with good separation, rather than combined in one or two large buildings. Where necessary to construct large buildings, or where large values are present, automatic sprinklers should be installed, provided, of course, water supply is available.

A good type of construction for such temporary buildings is corrugated iron on wood framing, or a frame building covered with fire-retardant roofing on roof and sides.

Construction Shops.

Construction shops should not be combined with storage buildings as most of the shop work introduces fire hazard, and if so arranged, large values may be involved in fire. A type of construction similar to that recommended for storage sheds can be used. Frequently shop buildings can be made a part of the completed plant, warranting better design and construction than if of a temporary nature.

Where destruction of the shops would seriously delay or stop work until rebuilt, this class of buildings, though temporary, is sometimes protected with automatic sprinklers.

Storage of Oils and Paints.

Oils and paints should not be kept in store houses or construction shops, due to the fire hazard which they introduce. Even with small amounts, a separate detached oil and paint house should be provided.

On large projects, where considerable gasoline is to be used, standard gasoline equipment, consisting of properly protected underground storage tank, should be installed. On smaller projects the gasoline should be kept in metal drums where it will not expose buildings or work under construction.

Local supplies of lubricating oils should be kept in substantial metal cans.

Only a day's supply of oil and paint should be taken on to the work at one time. Surplus remaining at closing time, or when work is completed, should be removed to oil and paint house.

Hazardous Materials and Devices.

Gasoline Torches, Lead and Soldering Iron Pots.

These devices introduce acute fire hazard, not only due to the unprotected flame, but also because of the gasoline hazard. They should be filled, stored, and, if possible, lighted outside of buildings under construction. They should be examined before being used. Defective torches should be immediately repaired or disposed of.

If necessary to have a small supply of gasoline available on the work, due to location and constant use of these devices, it should be kept in approved type metal safety can, but wherever practical the torch should be filled outside of the building.

Only safety matches should be used. (See "Matches.")

Charcoal Furnaces.

Used for soldering, tinning, drying plaster, preventing contents from freezing, etc. Charcoal heated pots introduce a considerable hazard. Fires have been caused by sparks flying from furnace, by hot coals dropping out of furnace when carried, moved or filled, and also by spontaneous combustion in the charcoal. Their use should be restricted. They should not be used in the presence of highly inflammable material, such as excelsior.

Charcoal pots with fire in them should not be left in the buildings at night, unless under the care of a competent employee. After use they should be emptied at a safe location.

The local supply of charcoal should be kept in a substantial metal can with metal cover, if inside of building. The main supply should be stored in a tight, dry building away from the construction work.

Lead Pots.

When necessary to use wood or coal-fired lead pots, as for instance when installing outside fire mains, care should be taken to see that they are not used at locations where they might start a fire through sparks. When leaving for the night, any fire or hot coals remaining should be extinguished.

Tar Pots.

Tar pots used in roofing, water-proofing, road building, etc., if coal or wood-fired, introduce spark hazard. (See "Lead Pots.")

Fires have occurred in cloth or rope mops used for applying tar on roofs. Such fires, though the causes are not definitely known, may have been due to spontaneous combustion. Mops should be removed to a safe location when not in use.

Oxy-Hydrogen and Oxy-Acetylene Cutting and Welding (and Similar Cutting, Welding and Brazing Flames).

Fires have been caused by hot metal or sparks developed during the process of welding or cutting with oxy-hydrogen or oxy-acetylene flames. Where necessary to use them, combustible material nearby should be removed or protected.

Frequently workmen's clothing is ignited by sparks. Where there is a great deal of this work to be done, clothing can be made fire-resistive through the use of ammonium sulphate or other fire resisting treatment, or woolen clothing should be used.

Clothing used during this work should be examined for sparks or smouldering fires before being placed in lockers or left in building.

Blacksmith Forges and Rivet Furnaces.

These should be so located and safeguarded that hot coals and sparks cannot come in contact with combustible materials. Hot rivets frequently cause fire by falling into inflammables. This hazard should be guarded against.

Lighting.

Oil Lanterns and Torches.

One of the most common methods for temporary or emergency lighting is the use of oil lanterns and torches.

Oil lanterns should be of the cold blast, tubular type, having metal font containing oil permanently attached to lantern frame. The burner should be securely attached to the font, and so arranged that the cage holding the globe will hold the burner on the font.

The so-called "Switchman's" type of lantern, having removable font, should not be used, due to danger of font becoming disconnected and dropping out when lantern is struck violently or dropped.

In using oil (kerosene) flare torches, care should be taken to see that flame cannot come close to combustible material. Frequently these torches overflow and burning oil drops to floor or ground underneath. They should not be hung directly against wooden walls or partitions.

Gasoline torches of this type should not be allowed on work, due to acute fire and explosion hazard attending their use.

Oil supply should be kept in main oil and paint house recommended above, and as far as possible the torches and lanterns should be filled outside of important buildings.

Where local supplies are necessary, substantial metal cans should be used.

Lamps or torches should never be filled when lighted. A man should be delegated to clean and fill torches and lanterns, and keep them adjusted and in repair.

Only safety matches should be used.

Temporary Electrical Installations.

Although of a temporary nature, these should conform in all essential details to the requirements of the National Electrical Code, published by the National Board of Fire Underwriters. Particular attention should be given to the question of support, insulation and fusing of wires and apparatus. Life hazard, as well as fire hazard, is brought about by defective electrical equipment.

Acetylene Torches.

Calcium carbide should be purchased in approved metal packages, not exceeding 100 pounds each, and should be stored at a location which is dry, water-proof and well ventilated. It should not be stored inside of important buildings under construction, or where it will endanger large values. When calcium carbide becomes wet or moist, acetylene gas is formed. This is one of the most violently explosive gases, aside from being highly inflammable. Only calcium carbide of the proper size should be used, as accidents may result from too rapid generation of gas.

The torches or flares should not be filled or tested near open lights or in important buildings. They should be examined and charged during daylight only. Care should be taken regarding the disposal of sludge removed from torches. This frequently contains unconsumed carbide and is, therefore, dangerous.

Power.

Boilers.

If boilers are enclosed as protection against weather or cold, the following precautions should be observed, unless, of course, the

structure is of non-combustible or fire-resistive construction. Proper clearance should be provided between building wall or roof and boiler breeching. Where a smoke stack passes through a wooden roof, the opening should be at least 12 inches greater in diameter for small stacks, and 18 inches to 3 feet greater in diameter for large stacks.

Metal protection consisting of a thimble and umbrella should be provided in the roof.

Ashes should not be thrown on or against combustible material or construction.

Proper clearance should be maintained between steam pipes and woodwork.

Locomotives and Cranes.

a. **Locomotives.** The hazard attending the use of locomotives is due to sparks or hot coals thrown off through stack, hot coals or ashes dropping from ash pan, or dumping of ashes containing hot coals near combustible material.

The spark hazard from stacks can be practically eliminated by the installation of a spark arrester on the locomotive stack before it enters the yard.

The ash pan of the locomotive should be examined frequently, kept in good condition, and locomotive should not be allowed to enter plant if there is danger of hot coals or sparks dropping from pan.

The locomotives should not be allowed to dump ashes inside of plant unless it is at a location where they will not come in contact with combustible material. Ashes should be wet down prior to or immediately after being discharged.

b. **Cranes.** The hazard from cranes, unless electrically operated, is identically the same as that from locomotives, and similar steps should be taken to provide spark arresters and take proper care of ashes.

Gasoline Engines.

Engines of this type should be kept clean and properly adjusted. The gasoline tank should be examined frequently and kept free from leaks.

Engine should not be filled while running.

Gasoline should be handled in safety cans of an approved type.

Engine exhaust should be kept clear of combustible material and where necessary to run it through wood partitions or other combustible construction, a clear space of at least 12 inches greater diameter than the exhaust pipe should be provided. Exhausts should not discharge against combustible materials.

Fires have occurred due to woodwork becoming oily through this cause and having been ignited by hot exhaust, or back firing.

Space around engine should be kept well ventilated so that gasoline gases will not remain in engine room or near engine.

Gas Engines.

Precautions outlined above regarding exhausts apply in general to gas engines.

The gas connection to the engine should be well supported by permanent iron pipe. If a rubber bag pressure regulator is used, it should be enclosed in a tight metal drum vented at a safe point through screened outlet. A shut-off valve should be provided in gas pipe outside of the engine room, or at a remote point, so that gas can be shut off in case of an emergency.

Electric Installations.

All electrical apparatus (even though of a temporary nature) such as cables, switches, rheostats, motors, etc., should be installed according to the National Electrical Code. (See "Electric Lighting.")

Steam Engines.

Where steam engines are installed for hoists and driving other construction machinery, the following safeguards should be observed:—

a. See "Boilers"; also "Locomotives and Cranes."
b. Steam pipes, including exhaust, should not be in contact with combustible materials.
c. Waste should not be used around engine to catch oily drip, or be left in contact with heated portion.

Heat.

Temporary heating installations usually consist of stoves, braziers, or salamanders, charcoal furnaces, (sometimes used for drying plaster) and oil stoves. On some work, depending upon size of project, steam or hot water heat is installed in offices, lunch rooms, hospital and at other similar locations.

Stoves.

Wherever warranted, brick chimneys supported on the ground should be provided.

For temporary installations, tile or cement block chimneys can be used. These should preferably be supported on the ground, but if placed on a wooden bracket a 3-inch stone or concrete slab 6 inches greater than the base in area should be used to support the chimney.

Where metal flues are used, the opening around the flue where it passes through woodwork, such as wall of building, partitions, ceilings, roof, etc., should be enclosed in a continuous pipe at least 6 inches greater in diameter than the diameter of the smoke flue, this pipe being continuous from ceiling through roof or through wall.

Ventilating openings should be provided in metal collars which are installed to hold smoke flue in center of this protection.

Chimney or smoke flue should extend to a point at least 3 feet above peak of roof. Where sparks may endanger surrounding buildings, spark arresters consisting of fine mesh (not over ¼-inch) wire screen securely fastened in place should be provided.

The stoves should not be placed within 3 feet of frame walls, partitions, etc., unless protected with metal heat barrier, and even with heat barrier they should not be nearer than 18 inches.

The floor underneath should be protected by sheet metal extending 2 feet in front of stove and 18 inches on both sides and back. Sand box is sometimes used instead of sheet metal protection.

Smoke pipe should be securely attached to stove and supported at frequent intervals with diagonal wires. The joints should be tight and, if necessary to run long lengths of pipe, they should be riveted.

Braziers—Salamanders.

Heaters of this type are more hazardous than enclosed stoves, due to danger from sparks and hot coals. They should not be used near combustible materials, or on wooden floors, unless flooring is properly protected with sheet metal or sand box. They should not be used in low frame buildings or rooms where there is possibility of sparks igniting roof or ceilings, neither should they be placed near wooden walls or partitions.

Oil Stoves.

Oil stoves should be kept clean and in good repair. They should be filled outside of building—never when lighted; and should not be placed where they may ignite combustible materials, or be easily overturned. When used on wooden floors, metal protection should be placed underneath, and stoves should be secured to floor if possible.

Charcoal Furnaces.

See "Charcoal Furnaces—Hazardous Materials and Devices."

Steam and Hot Water Furnaces.

These installations, although of a temporary nature, should include brick chimneys, substantially constructed metal flues, good clearance above furnace and flue. Non-combustible receptacles should be used for ashes.

Steam Pipes.

All steam pipes, even of the low pressure type, should be clear from all woodwork.

Where secured to woodwork they should be supported on standard metal hook plates.

Clearance should be provided where pipes pass through woodwork. For small pipes openings should be at least 1 inch greater in diameter than outside diameter of pipe, and for larger pipes 2 inches. Metal "V" plates should be used to hold pipe in center of opening. The above also applies to small steam pipes used for heating glue pots, coffee urns, etc., as well as large heating or power pipes.

Thawing Frozen Building Materials.

It is frequently necessary during cold weather to thaw sand, gravel, slag and similar materials before they can be used. This is usually done by building an open wood fire directly on the pile, or by building fire in a large section of pipe. The chief hazard from this is the danger of sparks or embers. Wherever possible steam should be used. Before using open fires make sure that sparks or embers cannot reach combustible material or construction. In thawing slag

with open fires it has been known to ignite and burn for some time. Care should be taken to see that smouldering fires do not remain and also that hot or smouldering slag does not come in contact with combustible materials.

Fuel.

Includes gasoline, fuel oil, kerosene, illuminating gas, both bituminous and anthracite coal, briquettes, wood, etc.

Fuel oil should be stored in properly protected tanks. Tanks should preferably be located under ground. If above-ground tanks of over 10,000 gallons capacity are used, earth embankments should be constructed around them. Above-ground tanks should have non-combustible supports. A main control valve to shut off discharge in case of emergency should be provided at tank.

For storage of gasoline, see "Storage of Oils and Paints"; also "Gasoline Torches."

Where illuminating gas is used, a valve should be provided in connection at the point where it is tapped into main. This valve should be kept accessible so that it can be easily closed in case of emergency.

The other fuels are practically non-hazardous, with the exception of soft coal which is subject to spontaneous combustion when stored in large amounts.

Wood, if used in large amounts, should be stored where it will not expose important buildings.

Housekeeping.

It has been estimated that at least fifty per cent of the fires which occur throughout the country are due to bad housekeeping. Many of the remaining fires would probably have been extinguished in the incipient stage but for improper housekeeping. The construction engineer should recognize the importance of maintaining the best housekeeping conditions compatible with the progress of his work. Some of the principal phases of good housekeeping are as follows:—

Yard Housekeeping.

Yard should be kept free of wood, refuse and other combustible materials. Such accumulations might result in fire spreading from one building to another. Furthermore, they provide footholds for flying embers and sparks, resulting in many small fires which expose the buildings under construction, and also disorganize the fighting of fire, as well as involving the possibility of overtaxing the water supplies, unless of a very substantial nature.

Frequently a detached separate space is provided and all wood refuse, consisting of odds and ends of boards, timbers, etc., is gathered up and piled at this location.

On large projects an incinerator is sometimes constructed for burning the wood refuse and other waste materials. Where this is done the stack, unless the incinerator is located a safe distance from the work, should be provided with a spark arrester—¼-inch mesh wire.

Burning grounds should be located a safe distance away.

Construction Building—Housekeeping.

Clean waste should be kept in a metal-lined bin or substantial metal cans having tight covers.

All dirty and oily waste should be kept in substantial metal oily waste cans which are emptied frequently.

Metal cans with covers should be provided in lunch rooms and locker rooms, and workmen should be required to place all lunch papers and other refuse in them.

The workmen should be required to keep their clothing hung up in an orderly manner. This will facilitate ventilation and will tend to retard spontaneous combustion, if dirty clothing or substances they may contain are so inclined. Should the project include installation of metal lockers these could be installed temporarily to safeguard this hazard. If the work will extend over a long period of time change houses with metal lockers should be provided.

Matches and Smoking.

The use of matches should be restricted and only those of the safest type (that is, which must be struck on prepared surface on side of box) should be used. The old parlor match and the birdseye or strike-any-where match are dangerous and can be ignited when crushed under foot.

The safety match, having impregnated stick, is considered the safest match available.

A great many fires have been caused by smoking. The question of prohibiting smoking depends upon the type of construction. It is difficult sometimes to make a sweeping regulation on this important subject. However, where large amounts of combustible materials are used in construction, it is well to prohibit, or at least restrict, smoking.

Safeguarding Records.

The need of protecting records is self-evident. Frequently it is found that tracings and blue prints, as well as specifications for the project, are stored in the construction engineer's office, or at some point on the work where a small local fire would destroy them. This might result in a most serious delay, holding up construction work until the plans and specifications were again developed.

Where warranted fire-resistive vaults should be constructed.

There are several insulated cabinets or lightweight safes on the market which possess sufficient fire-resisting value to protect records, papers and similar contents from being injured by fire which is not too severe or of too long duration, and when not subjected to severe injury by falling or impact of falling objects such as might be expected in the collapse of large buildings. These insulated cabinets or lightweight safes can be obtained in various sizes, and will undoubtedly afford adequate protection in the customary one-story frame construction office. When purchasing these devices, however, the label of approval of the Underwriters' Laboratories, Inc., should be specified in order to insure properly constructed and arranged cabinets or safes.

Another way to prevent complete destruction of records would be to keep tracings and a duplicate copy of the specifications at some other location than on the work. Where tracings are in constant use record blue prints can be made and immediately removed to outside storage vaults or other safe locations.

Temporary Structures.

During construction work it is often necessary to erect temporary wooden sheds, offices, enclosures or housings, platforms, etc. Before this work is done examination should be made to see if such structures form connecting links between important buildings, or if they introduce conflagration hazard.

Completion of Fire Stops.

Instead of waiting until a building is completed before installing fire doors on interior walls or wired glass windows or shutters, which protect against external or inter-exposure, these should be installed at the earliest possible moment when they will not be likely to be injured by future construction. In other words, the construction engineer should keep in mind the desirability of complete cut-offs, thereby limiting probable spread of fire.

Fire Protection.

Outside Aid.

Where the construction work is located within city or town hydrant protection, locate the nearest fire alarm box, or arrange to summon aid by telephone or other means.

If hydrants are available and water pressure is adequate, a supply of standard 2½-inch cotton rubber-lined fire hose should be provided. It should be kept on hose reels, or otherwise arranged so that it can be gotten into action without delay. By siamesing long lines together good streams can be obtained even with moderate pressures.

When outside of city or town limits, arrangements can sometimes be reached with the nearest municipality to send motor driven pumpers or chemical trucks in event of fire.

Aid can sometimes be obtained from nearby manufacturing plants.

In some instances railroads have portable pumping units which they will send if needed. In the latter case, the railroad tracks around the work should be left as clear as possible at night so that the railway equipment can enter plant without delay.

Investigation by the engineer in charge may uncover other channels from which help can be obtained. This work should be done before the construction work is under way so that, should fire occur, the channels from which assistance can be obtained and the method of giving alarm will be known. This will enable the construction engineer to summon help with utmost despatch.

General Notes.

An important phase of construction work which is frequently overlooked or neglected is the question of getting at least part of the fire protection system in in the early stages.

The completion of water supplies and installation of fire mains, hydrants and equipment should precede, if possible, the actual building construction. If automatic sprinklers, inside hose equipment and other major extinguishing apparatus are to be provided, the installation should be made as soon as possible after building is complete. When, due to conditions over which the construction engineer has no control, he is unable to develop major fire protection with building construction, first aid extinguishing equipment, which later on can be installed in the buildings, or even of a temporary nature, should be provided. Such equipment consists of water pails, sand pails, one-quart carbon tetrachloride extinguishers and the 2½-gallon acid soda extinguishers.

Where fire protection is delayed and construction work is located outside of city protection, hand-drawn or motor chemical apparatus can be provided. Hand-drawn apparatus usually consists of single tank, 33-gallon, or double tank, 45-gallon chemical engines. The motor apparatus usually consists of two 25-gallon, or larger, tanks. Extra charges for re-charging the engines should be kept on hand and where there are two or more available, by re-charging engines while the others are being discharged, an almost continual fight can be kept up.

Lumber Yard Protection.

For the protection of outside lumber yards and other places which will not be included in the completed fire system, and where temporary protection consisting of mains and hydrants is not warranted, a liberal supply of brine casks and pails should be installed. For this fifty-gallon oil barrels can be used. The exterior of these barrels should be painted red and they should be lettered in white "For Fire Only." Pails can be hung inside or placed on brackets attached to outside of cask. The casks should be covered.

Large lumber yards may warrant the installation of temporary hose connections, where water supply is available, supplied by above-ground mains. During warm weather water should be kept on system. When there is danger of freezing, piping can be maintained dry. Control valves for turning on water should be accessibly placed and certain employees should be instructed to turn on water as soon as fire is discovered.

Anti-Freezing Solutions for Water Casks and Pails.

Water pails and casks installed at locations where they may freeze can be filled with a solution of calcium chloride. Calcium chloride brine is far superior to brine made from common salt, inasmuch as it does not crystallize out of the solution as freely as salt, is not as corrosive and will resist much lower temperature. The following table shows amount of calcium chloride to be used for making brine to resist certain temperatures:—

Lbs. per Gallon of Water.	Temperature of Freezing.	Degrees Salometer.	Degrees Baume
½	+29 Fahr.	13	3
1	27 Fahr.	27	6
1¼	25 Fahr.	36	9
1½	23 Fahr.	40	10
1¾	21 Fahr.	44	11
2	18 Fahr.	52	13
2¼	14 Fahr.	62	15
2½	+ 3— 4 Fahr.	80	20
3	— 1— 4 Fahr.	88	22
3½	— 8—11 Fahr.	95	24
4	—17—19 Fahr.	104	26
4½	—27—29 Fahr.	112	28
5	—39—41 Fahr.	120	30
5½	—50—54 Fahr.	124	32

For ordinary temperatures at least 4 pounds per gallon should be used. For lower temperatures 5 or 5½ pounds per gallon should be used.

Accessibility.

For quick action at time of fire the fire protection must be kept accessible. This means that hydrants and hose houses must be kept free from obstruction. Well defined paths or roadways should be maintained. The same is true with interior building equipment. The materials being used or kept in the building must be so stored or arranged that they will not obstruct the equipment.

If, due to yard or building conditions, the apparatus is not conspicuous, signs or poles painted red can be used to indicate location.

Good yard illumination is desirable both to facilitate getting apparatus into action and to prevent accidents. An inspection should be made at night to check this important feature. Additional lights should be provided wherever hydrants, hose reels, roadways, entrances to buildings, etc., are not well lighted. Permanent lights are frequently installed at hose reel houses, fire alarm boxes and similar locations. It is customary to use red for fire alarm boxes and blue or green for other equipment.

Egress.

Proper exit facilities in large or high buildings are not only desirable to allow escape of workmen, but they also provide means for the firemen to enter building. As the work progresses this phase should be kept actively under consideration and if fire escapes or stair towers are part of the project they should be placed in usable condition at an early date. When conditions warrant, temporary ladders or other means should be provided.

Fire Inspection, Guards and Watchman Service.

The extent of this supervisory service depends largely upon the size of the project.

Where the construction work is part of the development of a plant already in operation, the plant inspection and watchman service can usually be extended to include the new work. On small projects the fire inspections, guards and watchman service are often combined.

Some supervision of this nature is needed, especially at night and when construction work ceases. The men on duty should be instructed regarding fire hazards, location of fire extinguishing equipment and how to summon aid. They should, furthermore, be instructed to give alarm immediately upon discovery of fire, and then do everything possible to extinguish it.

The importance of fire prevention should be strongly impressed upon them. Part of their work should be to see that dangerous conditions are immediately remedied. They should report in writing to the construction engineer the results of their inspection.

PART II.

Construction Notes.

Approved Devices and Installations.

Wherever possible when ordering materials having a bearing upon fire or accident hazards, appliances bearing the approval of Underwriters' Laboratories should be specified.

When installing electric wiring and appliances, fire doors and shutters, automatic sprinkler systems, wired-glass windows, and in fact all fire appliances, the standard rules and requirements of the National Board of Fire Underwriters should be carefully followed.

Inspection of Cut-offs.

The importance of carefully checking the construction of fire walls and fire stops is frequently not appreciated. Improper construction or assembling of materials may result in voids, unsubstantial walls, exposed reinforcing members, and many other defects which might cause failure at time of fire.

This applies not only to vertical cut-offs, but also to horizontal cut-offs, formed by floors in fire-resistive buildings.

There is one case on record where spread of fire into a reinforced concrete building, which resulted in many thousand dollars loss, was due to a 2-inch opening through a floor, this opening at one time having contained a pipe.

In the installation of fire doors, wired-glass windows, shutters, etc., as well as the proper construction of walls and floors, good workmanship plays a very important part in relation to their proper functioning and future maintenance. Most of the defects which develop in automatically operated devices are due to installation defects.

Outside Fire Protection.

Installation and Testing of Fire Mains.

Failure of fire protection equipment is not infrequently due to installation defects. Some of the most important phases of this work are discussed below:—

Trenching.

The depth of trench necessary to prevent water freezing in the pipe depends upon the locality and condition of ground. Even in warm climates where there is slight danger of freezing, the pipe

should be buried at least 2 feet below the surface of the ground to protect against injury from building collapse, and at a sufficient depth for proper support. Where temperatures during cold weather approximate zero, pipe should be buried about 4 feet. In northern climates, 6 or 7 feet may be necessary. The depth of bury should be measured from the top of the pipe.

Support of Main under Tracks and in Insecure Ground.

Pipe failure is likely to occur if mains are installed under railroad tracks where heavy locomotives or loaded box cars pass over them. There are several instances on record where 6-inch or 8-inch mains have been broken due to this cause. To protect fire mains against injury it is customary to place heavy timbers or piles under the tracks to support the track above mains so that the weight of the locomotives and cars will not injure piping.

Mains installed in swampy grounds or quicksand and similar locations should be supported on piling or concrete piers and the mains should be securely strapped to them.

Blocking or Strapping Dead Ends, Angles, etc.

Unless dead ends, bends, angles, etc., in the mains are securely blocked, they are likely to be forced off when high pressure is placed on the system, or water hammer developed when hydrants are operated at time of fire.

Two methods are employed. One is by strapping the hydrant or block in a dead end to the main and strapping angles or bends, and the other is by blocking the same with heavy timber, concrete block or large boulder.

Laying and Caulking Mains.

Frequently it is found that sticks and stones, clothing, tools, and similar articles get into the system through carelessness or otherwise, and later on obstruct hydrants, or may block the main itself. Before each length is connected it should be carefully examined to make sure that it is free from obstruction.

Ends of mains exposed in trench at night should be blanked off to prevent pipe being filled with dirt should it rain or water enter the trench.

Great care should also be taken when caulking joints. Unless properly leaded and caulked they may fail under pressure. Poor joints allow excessive leaking.

Testing Before Back-Filling.

Before a main is covered it should be tested to 150 pounds hydrostatic pressure; this pressure to be held for one hour. If pressures above 150 pounds are to be carried on the system, 200 or 250 pounds pressure should be used if the class of pipe installed will stand it.

Back-Filling.

The fine dirt or top soil should be thrown into the trench first. This should be thoroughly tamped under and around the pipe. Boulders or large rocks should not be thrown into the trench, as the main may be injured.

Hydrants.

When installing hydrants it is important that the hydrant be firmly blocked in position so that it will not be forced off by water hammer and high pressure, and that drainage be provided. Concrete block, large boulder or heavy timber is used for blocking hydrants or the hydrant can be strapped to the main.

For drainage, two or three bushels of coarse gravel or crushed stone should be placed around the base of the hydrant before backfilling is done. Ashes are not as effective as coarse gravel or crushed stone.

Fire Hose.

When fire hose is received it should be stored at a dry location and where it is not likely to be injured. As soon as possible it should be placed in hose houses or on reels or racks where it is ready for use.

Automatic Sprinklers.

The importance of looking out for small details in the installation of automatic sprinklers is fully appreciated by the National Board of Fire Underwriters, and the following is quoted from the Regulations governing the installation of Automatic and Open Sprinklers:—

"Experienced Workmen Recommended.—Sprinkler installation is a trade in itself. Inspectors cannot be expected to act as working superintendents, or correct errors of beginners. Sprinkler work should be entrusted to none but fully experienced and responsible parties.

"Care must be taken that after pipes are cut they are properly reamed in order to remove all burrs and fins; also that threads are cut to standard so that joints will be properly made without obstructing waterway. In applying the joint compound, care should be taken to place it on the pipe and not the fitting.

"All distributing pipes must be straightened before installation in order to prevent pockets between hangers which would interfere with the proper drainage of the system."

Good workmanship is extremely important from a maintenance standpoint, for poor workmanship, which results in leaky connections, etc., means that the sprinkler protection is interrupted when repairs are being made. As a matter of interest, 27% of the sprinkler failures recorded by the National Fire Protection Association were due to fire occurring when the water was shut off the sprinklers.

The engineer supervising the installation of automatic sprinklers should closely follow the Rules and Requirements of the National Board of Fire Underwriters. Compliance with these standards as a whole is absolutely essential if the proper protection is to be derived from the automatic sprinkler systems.

After the automatic sprinkler systems have been completed they should be tested at 150 pounds hydrostatic pressure; this pressure to be held for two hours. If higher pressures than this are liable to be developed under fire pressure, they should be tested at 200 or 250 pounds, as suggested for the fire mains.

Where the sprinkler system consists of several sections, each section should be placed in service as soon as completed. Furthermore, before large systems are finished it is often practical to cap or

plug riser or branches and place at least part of the system in service. This can be done to afford protection at night, also when work is temporarily held up due to lack of fittings, etc.

Inside Hand Hose.

Drip Connections.

It is almost impossible to get valves in hose outlets to remain tight, even under low pressure. It is, therefore, customary to install drip connections of a positive nature between the hose gate valve and the hose outlet itself,—a small ⅛-inch or $\frac{1}{16}$-inch cock valve is usually installed at the lowest point. The valve is normally kept open. This will prevent water from reaching hose. The drip connection is of vital importance if linen hose is installed, and is an added safeguard against injury with cotton rubber-lined hose.

After installations are complete the hose should be run out, as if at a fire, to ascertain if rack operates satisfactorily. Water should be discharged through hose connection, but preferably not through hose. Linen hose should never be wet, except at time of fire, and rubber-lined hose should not be used for tests during the construction period unless facilities are present for properly washing and drying it.

Chemical Engines and Extinguishers.

Chemical Engines.

Chemical engines of the single tank, 33-gallon type, or the double tank, 45-gallon capacity, are very effective pieces of fire fighting apparatus, coming between the small first aid equipment, such as 2½-gallon chemical extinguishers and water pails and the more substantial equipment, such as inside hose connections. Even in buildings equipped with automatic sprinklers and inside hose connections they form a valuable adjunct to the fire fighting apparatus. During the construction stage they are very desirable, being mobile; that is, mounted on wheels, so that they can be easily taken from one point to another. They are identical in operation with the 2½-gallon chemical extinguisher. During operation sufficient pressure is developed to force the solution in the engine from 40 to 60 feet, and the engine has sufficient capacity to last from three to five minutes. In many instances equipment of this type can be provided, pending the installation of major equipment.

Chemical Extinguishers.

2½-Gallon Acid Soda Type. These should be distributed at conspicuous and easily accessible points. They should be hung from the rear handle (provided for that purpose) and not from cap, with top about 5½ feet above the floor. When charged, a tag bearing date of recharging should be attached to rear handle.

One Quart Extinguishers.

Carbon Tetrachloride Type—suitable for electrical and oil fires —should be hung at accessible locations, with top not over 5½ feet above the floor.

Water and Sand Pails.

These are usually installed in groups averaging from two to six. The most common method is to place them on shelves, about 4 feet

above the floor. They are sometimes hung on metal brackets. Where sand and water pails are installed together they should be on the same level.

Tests.

When the fire protection system, that is, water supply mains, hydrants, automatic sprinklers, etc., is fully completed, it should be carefully inspected and tested.

The following are some of the points to be checked:—

a. Tanks and reservoirs should be filled and checked for leakage.

b. Pressure test should be made on mains, automatic sprinkler and standpipe systems, as specified above.

c. After pressure test, static pressure should be placed on entire system to determine if it is leaking excessively.

d. Shut-off tests should be made on all valves, and direction of operation given on wheel, cap or nut should be checked. All valves should be uniform in operation, preferably right hand, or closing to the right, or clockwise. Left hand valves, or those closing counter-clockwise, unless greatly in the majority, should be changed to operate right hand, so that the valves in the entire system become uniform in operation. If all but a few of the valves are left hand, that is, close by turning valve wheel or wrench to the left, or counter-clockwise, the right hand valves should be changed so that all valves in the fire protection system are uniform in operation, and signs should be posted to the effect that they operate in opposite direction to the ordinary valve.

e. Hydrants should be operated to make sure that they are in operative condition and free from obstruction.

f. Flowing tests should then be made, using all hydrants, drains on sprinkler risers, standpipes, etc., in order to ascertain if mains and connections are free from obstruction.

g. Fire pumps should be run at full capacity, both as regards volume and speed.

In other words, the inspection and tests should uncover any deficiencies in installation. The system should be left ready for use.

In Conclusion.

Now, as never before, we should all strive to reduce the tremendous fire loss which is increasing every day. Almost every plant is being enlarged or re-arranged to meet increasing demands, and consequently becoming more and more congested. This condition has been vividly shown in the fire record for the last few months. It is, therefore, apparent that most radical steps must be taken. Every loss must be and is borne directly by us, while the destruction of food, clothing and the necessities of war, and the delay in manufacturing these essentials, may, in addition, have a direct bearing upon the outcome of the present war. Therefore, if disastrous fires are occurring in plants already provided with fire-fighting facilities, how much greater effort should be made to prevent fires occurring on construction work where there is available little, if any, apparatus or means to extinguish a fire.

Installing Equipment in Concrete Buildings.

The Use of Inserts; Providing for Heating and Water Pipes, Sprinkler Systems, Sanitary Plumbing and Machinery

By Harold L. Alt

Courtesy of Concrete.

The reinforced concrete factory and industrial building solves the construction problem in a highly satisfactory manner and with a material which is permanent, fire-resistive and indestructible. Yet its very indestructibility introduces an element of objection when the time comes to install the equipment necessary for the structure to serve its purpose, unless this has been properly provided for in the construction.

For industrial buildings such equipment usually consists of machinery, shafting, piping, toilet facilities, heating, sprinkler system, roof leaders, etc. These again may be classified into equipment hung on the ceiling—such as piping, shafting, etc., equipment hung on the walls—such as radiators, steam risers, etc., and equipment set on the floor—such as toilet fixtures and machines.

There is usually no good reason why all the equipment for a building should not be decided upon and designed before the pouring of concrete is begun. In spite of this, the common experience is to find a concrete building being poured long before the equipment has received any thought whatsoever. After the forms are pulled, it is suddenly discovered that a sprinkler system is required with 6-inch risers running through all the floors, and that water closets must be set in the toilets with 4-inch outlets on 3-foot centers. Then electric or pneumatic drills get busy and the carefully designed concrete slabs are chopped and hacked until the steel rods, which should have been carefully bent around such openings, are severed and the material put in the slab is, to a large extent, wasted owing to the resulting reduction of strength.

It has been found that the most successful method of attachment to wall or ceiling is by means of a small iron casting—commonly termed an insert, which is fastened to the form in its proper position. When the forms are pulled the inserts remain, the insert being held in the concrete by its anchor and its fastening to the form snipped off.

Another way is to build in bolts at the required points, the main objection to this being the unsightliness of the projecting bolts where they are not used, and sometimes they are numerous. Cutting off the bolts is by no means an easy job; there is no flexibility in their use, being cast absolutely solid in the concrete. Another bolt difficulty is in the fact they are easily displaced during the pouring of the concrete.

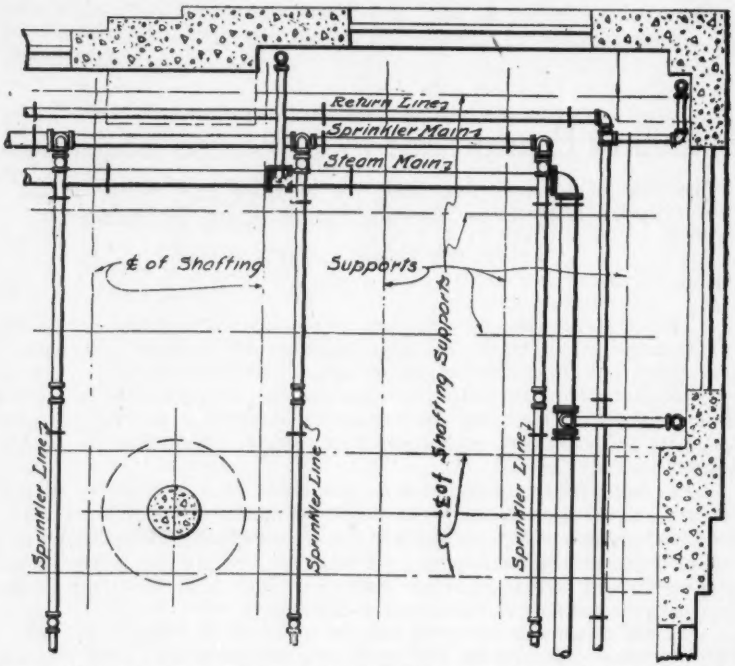


Fig. 1. Typical corner bay of concrete building with provisions for shafting, sprinklers and steam heating.

With inserts a certain amount of flexibility is obtained and any that are not used can easily be filled with oakum held in by a little plaster of paris or cement so that the hole can be cleaned out easily if it is desired to use the insert at any future time.

Inserts come in several styles, one in which a nut is shoved up into a recess in the head of the insert and the bolt screwed into the nut; another has a square opening (into which the head of the bolt is inserted), and a connecting slot into which the bolt slides, the danger of backing into the inserting opening being prevented by cementing up that end of the slot at the time of placing the bolt.

With the slotted insert it is customary to set the insert with the slot turned crossways to the line of the load applied. Thus on a line of pipe where the movement of expansion will be lengthways of the pipe the slots are set crossways, but where side guides are used for anchors, the slots are set lengthways of the pipe, as the pull in this case is at right angles to the pipe.

It is not readily determined at the time of erection what every possible layout of shafting will be at some future time. Therefore, it is necessary to place shafting inserts so as to permit the erection of shafting timbers at almost any point on the ceiling and running either

longitudinally or transversely of the building.

To accommodate this requirement it has become common practice in many concrete buildings to locate inserts throughout the floor slabs—on the bottom—so as to allow the bolting up of shafting timbers run in either direction. In order to do this with the minimum number of inserts a typical bay or section of the building is selected and lines are drawn through this portion indicating positions of timbers to support the shafting run in one direction. Care is taken in locating these places to keep a proper distance away from the columns so that not only will the line of shafting and reasonable sized pulleys clear the columns but will also clear the mushroom top or beam haunch when such construction is used. It is generally considered sufficient if a 36-in. pulley can be mounted on the shaft at any point without interference with the construction.

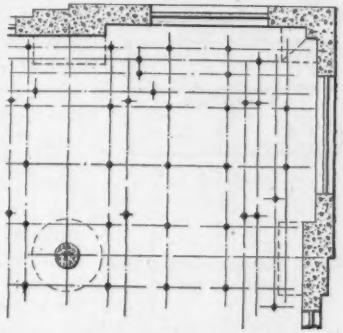


Fig. 2. Lay-out with various symbols for inserts for shafting, sprinklers and heating.

The scheme is then changed and laid out with the lines of shafting run at right angles to the first scheme. At all points where the lines of the first scheme cross the lines of the second scheme an insert is placed so as to serve equally well whichever method may later be adopted.

If a sprinkler system is to be installed the shafting timbers must be arranged so as not to come directly over the sprinkler lines.

The location of the inserts for sprinkler piping must be placed directly over the pipes and near the heads—12 inches to 15 inches distant being best—and the piping must be supported at every head on the branches. The mains are usually hung at 10-foot intervals and are supported without anchors.

Where steam and return mains are run around the ceiling—which is usual in the lowest story—inserts are located at intervals of every 8 to 10 feet and the middle of every long run is held by an anchor with side ties to prevent lateral movement when expansion takes place. For such anchors usually four inserts are installed, as follows:

Two directly over the pipe with the slots crossways and spaced about double the distance from the ceiling to the pipe. Two lateral inserts are placed midway between the other two and with the slots turned lengthways with the pipe. One lateral insert is placed each side the pipe, the lateral distance being about equal to the distance from the ceiling to the center line of the pipe.

Fig. 3. Various openings and sleeves for pipes.

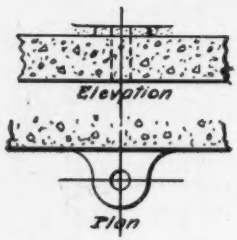


Fig. 4. Raised sleeve or curb around pipes.

Fig. 1 shows a typical corner bay of a modern concrete building provided with shafting, sprinklers and steam heating; the possible location of the shafting timber is shown with dot and dash center lines and the sprinkler branches, supply main, steam and return pipe are all indicated. It will be noted that the lowest pipe (the return line) is placed in a position nearest the column brackets, as a low pipe will clear these brackets when a higher pipe would interfere with them. The points at which it was decided to hang these pipes are indicated by small cross lines placed on the pipe.

The man in the field cares little as to such details of piping as are shown in Fig. 1, his chief worry being to see that the inserts are properly located on the forms before the steel is placed and the slab poured. For his guidance a plan showing the location of each and every insert is prepared, this being somewhat on the style of the sketch shown in Fig. 2, where each insert is shown and (for the sake of clearness) a different symbol is used for each line on which the inserts are located. Of course for a purely location plan different symbols are not needed but if different sizes of inserts are used (such as ½-inch on small sprinkler branches, ⅝-inch on steam return and ¾-inch for steam supply, sprinkler mains and shafting) these symbols can be used to indicate the size of the inserts instead of the lines on which they may be located.

In deciding on the location of inserts it is a great help in the field if a systematic arrangement is used and as few as possible of the separate location lines employed; it will be noted that this has been done to some extent in Fig. 2.

Machinery located on the floor is generally lagged down with lag screws of small size, these seldom taking a hole over ¾-inch in diameter. In these holes the lag screws may be grouted, set in hot sulphur or expansion bolts may be used. Such machinery requires no consideration at the time of slab casting and may, therefore, be omitted from this discussion.

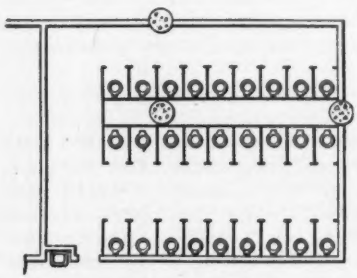


Fig. 5. Plan of toilet room for which openings had to be provided, avoiding all beams.

On the walls, clamps for vertical pipe and brackets for radiators or pipe coils are used, these bolting up to inserts located in proper positions to suit the particular support being used. The slots in such inserts are all turned horizontally.

Having arranged for the proper support of the building equipment the next consideration is in providing holes in the floors for the various pipes, plumbing fixtures, hot blast ducts, etc. Several types of openings and sleeves are illustrated in Fig. 3. These consist of a plain

hole in the slab, A, a plain pipe sleeve, B, a raised pipe sleeve, C, pipe and coupling sleeve, D, pipe and floor flange, E.

Some cases have been found where sleeves formed simply of ordinary pipe of proper length have in time loosened up from the concrete and dropped down on the pipe. To avoid such a difficulty a tap screw set in the sleeve, the termination of the sleeve with a common pipe coupling on the top, or a floor flange will prove much better. If sleeves are not used wooden plugs are placed in the floors, these being slightly tapered and removed with the forms.

Where sprinklers are used scuppers are placed in the outside walls and all pipes passing through the floors are surrounded by sleeves extending about 3 inches above the floor or by carrying a concrete curb (formed in the finished floor) around the opening for the pipe as shown in Fig. 4.

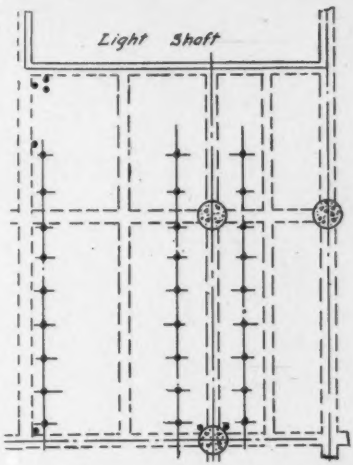


Fig 6. How the openings were provided for plan in Fig. 5.

When pipe sleeves are employed it is customary to make the nominal diameter of the sleeve 2 inches greater than the nominal diameter of the pipe around which it is placed, while if plugs are used the smallest end of the plug is made 2 inches larger than the nominal diameter of the pipe going through the hole; no holes or sleeves are made less than 3 inches, this giving a schedule of holes somewhat as follows:

Nominal Size of Pipe	Smallest End of Plug	Size of Pipe Sleeves
3/8", 1/2", 3/4", 1"	3"	3"
1 1/2", 2"	3 1/2", 4"	4"
2 1/2", 3"	4 1/2", 5"	5"
3 1/2", 4"	5 1/2", 6"	6"
4 1/2", 5", 6"	6 1/2", 7", 8"	8"
8"	10"	10"
10"	12"	12"

The openings sized on this basis are large enough to take the bead of the pipe fitting if necessary and should in all cases be covered with floor plates after the pipes are installed. Where refrigeration or drinking water piping is installed it is desirable to make the holes or sleeves large enough to take both the pipe and the covering intact. Thus, for 3/4-inch, the covering will require holes and sleeves only as listed above, but for 1 1/2-inch covering the list should be as follows:

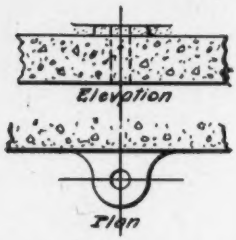


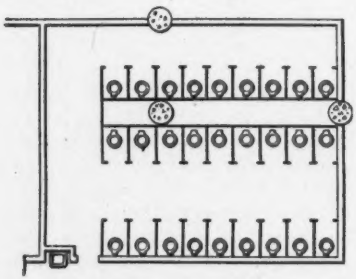
Fig. 4. Raised sleeve or curb around pipes.

Fig. 1 shows a typical corner bay of a modern concrete building provided with shafting, sprinklers and steam heating; the possible location of the shafting timber is shown with dot and dash center lines and the sprinkler branches, supply main, steam and return pipe are all indicated. It will be noted that the lowest pipe (the return line) is placed in a position nearest the column brackets, as a low pipe will clear these brackets when a higher pipe would interfere with them. The points at which it was decided to hang these pipes are indicated by small cross lines placed on the pipe.

The man in the field cares little as to such details of piping as are shown in Fig. 1, his chief worry being to see that the inserts are properly located on the forms before the steel is placed and the slab poured. For his guidance a plan showing the location of each and every insert is prepared, this being somewhat on the style of the sketch shown in Fig. 2, where each insert is shown and (for the sake of clearness) a different symbol is used for each line on which the inserts are located. Of course for a purely location plan different symbols are not needed but if different sizes of inserts are used (such as ½-inch on small sprinkler branches, ⅝-inch on steam return and ¾-inch for steam supply, sprinkler mains and shafting) these symbols can be used to indicate the size of the inserts instead of the lines on which they may be located.

In deciding on the location of inserts it is a great help in the field if a systematic arrangement is used and as few as possible of the separate location lines employed; it will be noted that this has been done to some extent in Fig. 2.

Machinery located on the floor is generally lagged down with lag screws of small size, these seldom taking a hole over ¾-inch in diameter. In these holes the lag screws may be grouted, set in hot sulphur or expansion bolts may be used. Such machinery requires no consideration at the time of slab casting and may, therefore, be omitted from this discussion.



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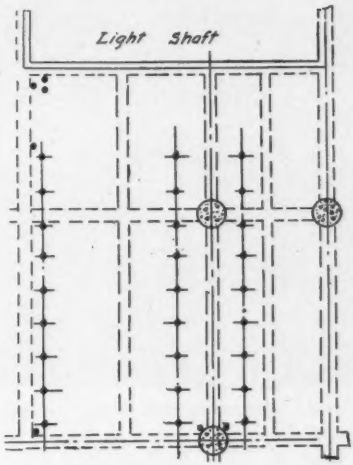

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Nominal Size of Pipe	Smallest End of Plug	Size of Pipe Sleeves
½", ¾"	4"	4"
1", 1¼", 1½"	4¼", 4½", 5"	5"
2", 2½"	5½", 6"	6"
3", 3½", 4"	6½", 7", 8"	8"
5"	8½"	9"
6"	9½"	10"
8"	11½"	12"
10"	13½"	14"

and for 2-inch covering:

½", ¾"	4¾", 5"	5"
1", 1¼", 1½"	5¼", 5½", 6"	6"
2", 2½", 3", 3½"	6½", 7", 7½", 8"	8"
4", 5"	8½", 9½"	10"
6"	10½"	12"
8"	12½"	14"
10"	14½"	16"

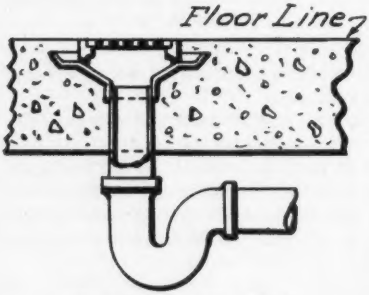


Fig. 7. Type of floor drain.

As an example of difficulties which must be met and provided for, the toilet room shown in Fig. 5 may be taken. This toilet was laid out so as to set over a beamed construction and had to be arranged so that no fixture came with its outlet on a beam. At the same time the room on completion must present a logical layout without having the fixtures sprinkled around in haphazard manner. This was finally accomplished by the arrangement shown and the holes for this arrangement came as indicated in Fig. 6.

For floor drains there should be provision for some sort of flashing to prevent leakage around the drain onto the floor below. One of the best drains to use in such cases consists of a strainer surrounded by a saucer with weep holes leading into the interior of the drain so that any leakage will follow down the sides, be caught by the saucer and ultimately find its way through the weep holes. An example of such a drain is shown in Fig. 7, and it will be noted that the hole in the slab is kept down to the minimum, the saucer setting on top of the rough construction with the finished floor carried up over the saucer to the strainer edge.

Fig. 1. Cylinder used in first Creosoting plant, built in 1865 at Somerset, Mass.

The Creosoting Industry with Relation to the Fire Hazard.

By Hermann von Schrenk

(Member N. F. P. A.)

The use of coal-tar creosote for the preservation of wood against decay dates back several centuries, but its extended use in Europe practically started with the operations of John Bethel, who took out a patent in 1838 for the treatment of timber in cylinders, under pressure.

Development of the Creosoting Industry.

Following Bethel's lead in England, numerous operations started in various European countries. The treatment was attended with great success. Beech ties which ordinarily gave a length of life of four years, gave an average service of 25 to 30 years when creosoted, and similar lengths of life were obtained with pine, oak and other construction timbers. At the present time there are approximately 75 plants in operation in Europe, treating about 16 million ties per year, together with a large quantity of poles and miscellaneous lumber. The use of creosoted lumber around farms and in general building construction has developed to a very great extent abroad.

In the United States the earliest wood preserving plants (Kyanizing plant built at Lowell, Mass., in 1848, etc.) used corrosive sublimate and zinc chloride. The first creosoting plant was built by the Old Colony Railroad at Somerset, Mass., in 1865. The old cylinder is still back of the railroad station at Somerset today (see Figure 1). A number of smaller plants were built after this one, but the

first extensive use of creosote for timber preservation probably started with the erection of the West Pascagoula, Miss., plant of the L. & N. in 1875. This plant was followed by that of the Eppinger & Russell Co., built in 1878 at Long Island City, N. Y., the New Orleans Northeastern plant in 1879, and the Wyckoff Pipe and Creosoting plant at Portsmouth, Va., in 1881. Since that time there has been a very rapid development both on the part of private corporations and on the part of railway companies. At present there are 109 pressure plants in operation in the United States and six in Canada, and 32 non-pressure plants, practically all of which use creosote. The principal materials treated are railroad ties, construction timber for bridges, buildings, etc., telegraph and telephone poles, piling, paving blocks, cross-arms and miscellaneous lumber.

The development of the creosoting industry can perhaps be best illustrated by indicating the amount of creosote oil used in the United States during recent years. 51,426,212 gallons of creosote oil were used in 1909; 108,373,359 gallons in 1913; and 90,404,749 gallons in 1916. The drop from the 1913 to the 1916 consumption is due to the shut-off of the foreign oil supply on account of the war. The amount of material treated with creosote oil in 1916 is shown in the following table:—

Ties	62,576,403 cu. ft.
Construction timber	9,521,609 cu. ft.
Poles	6,303,954 cu. ft.
Piling	8,524,680 cu. ft.
Cross-arms	178,210 cu. ft.
Miscellaneous lumber	691,870 cu. ft.

The total amount of timber treated in 1916 with all preservatives amounted to 150,522,982 cu. ft., so it will be seen that more than half was treated with creosote oil.

Construction of a Creosoting Plant.

A modern creosoting plant consists of two parts, namely, the seasoning and shipping yard and the creosoting plant itself. On account of the large amount of room necessary, most plants are situated at some distance from larger cities. The size of the seasoning and shipping yards depends upon the amount of material treated. It will run all the way from 5 to 75 acres. A series of parallel tracks, usually 100-feet centers, divides the yard into a number of sections, so arranged that the ties, timber, piling, etc., can be conveniently unloaded from cars to the ground for proper seasoning, narrow-gauge tracks being run parallel to the standard gauge tracks, either as part of such track system or half way between the standard gauge tracks, on which small trams or buggies are operated either by cable, electric locomotive or steam locomotive. The shipping part of the yard usually consists of what are known as loading docks, on to which the tram tracks run in such manner that the creosoted material can be readily unloaded from the trams on to cars ready for shipment.

The creosoting plant itself is composed of one or more cylinders, which are usually from 110 to 150 feet long and from 6 to 7 feet in diameter. These cylinders have one or two movable doors at the end

and are provided with tracks in the bottom and with the necessary pipe connections for the admission of the creosote oil, steam coils, etc. In the retort house or in an adjacent building will be found air compressors, pressure pumps, vacuum pumps, recording gauges and other necessary machinery for properly conducting the process. Most modern creosoting plants have high pressure fire pumps as an integral part of their engine room. A number of large storage tanks for holding the creosote oil are situated close to the creosoting plant and are connected with pipe lines to the cylinders and pumps of the treating plant itself.

The general manner of operation will depend upon the process used, as will be indicated directly, and which is practically as follows:

The timber to be treated is received at the creosoting plant and is piled in the seasoning yard, where it is thoroughly air seasoned. Careful attention is given to methods of piling so as to prevent decay of the timber during the seasoning process. Every possible effort is made to keep the yard free from weeds and decaying wood of any sort which might in any way influence the material stored on the yard. In most cases the yard is covered with cinders or some other inert material. In constructing the piles careful attention is given to spacing, particularly with reference to the construction of fire alleys. After the timber is properly seasoned, it is piled on to the small trams. These are switched to the front of the cylinder house and shoved into the retort. The doors are then closed and the treatment proper begins. This may consist either of the introduction of steam, compressed air, the creation of a vacuum, etc., depending upon the process to be used. This is followed by the filling of the cylinders with creosote oil, at a temperature of 180-200° F, which is then forced into the timber under pressure of usually 180 to 200 pounds for as long a time as may be necessary for properly conducting any particular process. After the injection of the oil, the oil is run out and a final vacuum, air pressure, steam treatment, etc., follows, as may be determined by the process used. The doors are then opened, the trams are pulled out on to the loading dock, and the creosoted material is loaded into cars for shipment.

Processes Used.

There are many different methods used for injecting the creosote oil. The choice of any particular process is determined largely by the ultimate use to which the timber is to be put and the cost.

The oldest process used, called the Bethel process or straight creosoting process, is one in which a preliminary vacuum is first created (sometimes preceded by steaming for a brief period), after which the creosote oil is forced into the wood until anywhere from 10 to 20 pounds of oil per cubic foot are absorbed. This completes the treatment. This process is used for timbers which are to give long service and which are not subjected to excessive mechanical destruction, such as piling, telephone and telegraph poles, bridge materials, paving blocks, etc.

In view of the high cost of this treatment, varying from $10.00 to $20.00 per 1,000 feet board measure, two other processes were de-

veloped during the past 15 years, applicable particularly to timbers in which the mechanical wear reduces the length of life irrespective of the preservation. The processes most largely used in this country are the Lowry process and the Rueping process. Both consist of the introduction of the maximum quantity of oil, so as to give penetration to the timber, and a subsequent withdrawal of some of the oil, thereby materially reducing the cost. In the Lowry process the oil is pumped into the wood without the creation of a preliminary vacuum, and after the maximum absorption is obtained, the oil is dropped into an underground cylinder and a final vacuum created, which results in the withdrawal of a considerable amount of the oil. In the Rueping process air is pumped into the cylinder at the outset, followed by oil injection and a final vacuum. These processes are most extensively used for the treatment of cross-ties.

Fire Protection of Plants.

Practically all creosoting plants in the United States have developed a very high system of fire protection. Water mains are laid throughout the seasoning yard and hose houses with complete equipment are located at frequent intervals throughout the yard. One or more high pressure fire pumps are ready for immediate service in the engine house. Fire alarm boxes are placed at various points in the yard. The employees of the creosoting company and such others as may be employed about the plant are organized into fire companies, who drill at frequent intervals. It is probably due to the great care used in this respect that there have been so few fires at creosoting plants in late years.

Fire Resistance of Creosoted Timber.

With the rapid development of the use of creosoted timber, its fire resistance became a matter of very considerable interest to railroads and others using large quantities of creosoted material. A number of tests were conducted to determine the relative resistance of untreated and creosoted lumber. The writer conducted a series of such tests about twelve years ago on one of the western railroads. To be sure, these were rather crude, but they gave the desired information. A number of piles of untreated white oak ties were constructed along the right of way, and nearby a number of piles of freshly creosoted red oak ties. The inflammability of untreated red oak and untreated white oak are practically the same. It was desired to determine to what extent the treated red oaks would burn when compared with untreated white oaks. A large fire was built of coal and several large scoop shovelfuls of live coal were placed on the untreated white oak piles and on the treated red oak piles. Both took fire very quickly and after burning about ten minutes the fire on the creosoted red oak piles went out, while the white oak piles burned so vigorously that it was with the utmost difficulty that the fire was extinguished. Tests of this sort were conducted at various points throughout the Central West and gave the same results in each case. The conclusion drawn was that the creosoted red oak ties were less inflammable than the untreated white oak, a conclusion which has

been extensively borne out in practice, as indicated by the loss due to accidental fires along the right of way caused by locomotive sparks and by grass fires.

Through the courtesy of the Insurance Department of the Pennsylvania Railroad, Mr. R. H. Newbern, Superintendent (Member N. F. P. A.), we are able to print below the report of the department on the tests made by it in 1911.

Fire Tests Creosoted Wood, Greenwich Point, Philadelphia, Pa. August 29, 1911.

General:

The use of creosoted wood for ties and in other forms of railroad construction is constantly increasing and gives promise of coming into more general use in other kinds of building construction, thereby making advisable a more definite knowledge of its effects on the fire hazard. At the present time creosoted wood is used more or less extensively for ties and also to a less extent for bridge stringers, caps, sills, posts, pier floors, crossing plank, piling, telegraph poles, brackets and cross-arms, fence posts and guard rails.

Heretofore various theories have been held as to the effects of the creosote treatment on the fire risk, but these have mostly been conflicting, and there appears to be no accurate knowledge available on the subject, based on actual experiments.

In two instances, fires involving Company's property where creosoted timbers had been used were investigated by this Department, and in each case the effects of the presence of the creosote produced an opposite result, due apparently to the difference in the age of the treatment of the timber.

Object of Tests:

To afford an approximate comparison of the relative hazards of treated and untreated wood of both hard and soft fibre.

To determine the inflammability of creosoted timber for various periods after treatment, ranging from one day to twelve months.

To obtain a fairly reliable working knowledge of the general effects of the creosoting treatment on the fire risk covering all classes of structure where preservative treatment of wood might be considered.

Creosote:

For the preservative, both the heavy German and English oils are used, the analysis varying within limits of which the following is a fair average:

	Specific Gravity	Water	Below 210°C	Below 235°C	Total Residue
German	1.06	1.30%	4.00%	23.00%	10%
English	1.028	0.40%	4.140%	26.140%	15%

As a rule, most of the creosote oil is obtained from gas or coke oven tar without any admixture of tar, oil or residue obtained from petroleum or other sources except gas or coke oven tar, and in no case is more than 3% of water permitted.

Description of Creosoting Treatment:

At Greenwich two distinct methods of treatment are employed, known as the "empty" and "full" cell processes. The character of the treatment depends mainly upon the kind of wood, and to a less degree upon its prospective use. In both treatments the wood is first thoroughly air-seasoned for periods ranging from six to twelve months.

Ties or timber for treatment are loaded on small steel tram cars and shifted through the yard and into the cylinder by means of a small "dinkey" locomotive. Each of the cars has a load capacity for 30 ties, the maximum charge for a single treatment comprising 15 cars and 450 ties. The treating cylinder is of heavy riveted steel, having a door opening in the yard end, which during the treating operation is closed to permit of the application of the required pressure to insure heavy absorption of the oil.

Full cell treatment is used on woods which are not exposed to mechanical injury, such as bridge timber and piling, excepting that paving blocks are treated full cell. All ties excepting oak are treated empty cell.

In the full cell treatment the wood is first placed in a treating cylinder and a vacuum ranging from 21 inches to 26 inches drawn, after which the creosote is admitted into the cylinder at a temperature of 180° under 175 pounds pressure and forced into the cells of the wood; this pressure being maintained until the required amount of oil is injected, varying from twenty minutes to two hours. The temperature of the oil in the cylinder is kept constant by means of steam coils, the hot oil afterwards being forced back to the working tank and a vacuum of 21 inches to 26 inches put on to dry the timber of any surface adhesion of the creosote.

In the empty cell treatment the ties are first placed in the cylinder, after which they are first subjected to an initial pressure of 50 pounds, to fill the cells and cavities of the wood. The creosote oil is then admitted to the cylinder. After the wood is thoroughly immersed, the pressure in the cylinder is raised to 180 pounds. Before removing the wood from the cylinder, a vacuum of from 21 inches to 26 inches is put on to dry off the timber. The object in first filling the cells with air is to force out the creosote after the pressure on the creosote is released when the fibre has become thoroughly impregnated. This treatment requires about 45 minutes.

The amount of creosote oil per cubic foot varies according to the kind of treatment. In the full cell treatment the average is about 12 pounds for ordinary timber and 9 pounds for ties, and in the empty cell approximately 8 pounds for timber and 6½ pounds for ties.

General Description of Tests:

Tests were held in the open on the new cinder fill addition to the tie storage yard; the wind velocities ranging from 11 to 20 miles per hour.

The test samples used included long and shortleaf yellow pine and red oak of uniform length, i. e., 2 feet, width and thickness varying, ranging from 7 x 9 to 10 x 13. Each piece had one untreated end, due to having been sawed from the original stick after treatment.

The test covered in all seven samples, three of which were tested simultaneously to enable a comparison of conditions during the progress of the fire, the remaining samples being tested separately.

The conditions of the test were as nearly uniform as the facilities would permit. A separate fire was built for each sample, which was kindled with 50 pounds of yellow pine wood split into pieces of 2 inches in length, and ignited by half-pound of dry cotton waste.

In order to secure the required draft, each test sample was raised 4 inches above the ground by means of bricks placed under each end. The waste was laid underneath and kindlings placed in a nearly upright position against the test pieces.

The readings were taken at intervals of two and three minutes apart as noted, the total duration of each test ranging from 15 to 23 minutes.

Observations of Tests:

Within the limits the tests showed that the treatment of timber with creosote oil does not appreciably lower its ignition point beyond that of untreated wood until the fire has generated heat to drive off the gases. There was practically no difference in the rate of combustion between the treated and untreated samples until the fires had been burning six minutes, when it was noted that the treated samples burned more freely along the exposed surfaces of the wood, although the flame did not at this time attack the fibre, the fire appearing to be principally due to the burning of gases which were given off more rapidly as the heat of the fire increased.

After a three-minute period, the smoke from the test samples became increasingly dense, and continued until the flames attacked the wood; it was then noticeable that the gases decreased, although there was some evidence of oil flowing out from the cells of the wood at the ends near the underside; oil drippings from the wood were first noticed at six minutes after the fire

had been started, and flowed more freely from those samples that had been treated six months or over on the full cell process.

The above deductions do not include observations on test samples which had been freshly treated. In these tests the wood was noticeably slow in igniting, and the gases given off were so dense as to materially retard the spread of the fire. In addition to which it is believed that the moisture from the liquid creosote flowing from the cells tended to produce a quenching effect, checking the spread of the fire.

The burning qualities of the creosoted timber, which has been treated two months or longer appear to reach their maximum in a period of six minutes' duration, were comparatively fast burning and quickly spread over all of the exposed surfaces of the timber. In this connection it was noted that there is comparatively little difference between timbers treated six months and a year, as the fire conditions of the latter closely approximate the conditions of the former.

In the untreated samples the fires were less free and noticeably slower than for the creosoted woods. These samples, while slow-burning, showed that the fire was more deeply seated in the fibre than in the creosoted sticks, and would seem to warrant conclusions that in any fire where the heat had become sufficiently intense, due to its spreading area, the untreated timber would burn as freely as the creosoted timber, and that within limits the fire would be more difficult to control than where treated timbers are used. As between the full cell and empty cell treatments, the log shows comparatively little differences in their effects on fire conditions, though the former burned somewhat more freely, and the fire appeared to be hotter where the age of the treatment exceeded two months.

The conditions of the char on the treated and untreated samples would indicate that the greater intensity of the fire in the former was due directly to the burning of gases given off by the creosote, which was noticeable in the interstices along the surface of the wood. In all of the treated samples the char was softer and of a more open character than in those untreated, the latter being hard and close.

Conclusions:

An analysis of the log in connection with the general observations above indicate that the treatment of wood with creosote does not unduly increase the fire risk except as the presence of treated wood may tend to increase the intensity of a fire after it has passed an early or incipient stage, that the creosote will make a faster fire for a comparatively brief space until the gases have been driven off; thereafter its burning qualities should approximate those of untreated wood.

Creosoted wood in the early stages of a fire will be particularly objectionable on account of the dense volume of smoke given off, which will be less as the treatment ages.

In order to obtain definite information as to the relative inflammability of creosoted and untreated timber, a number of tests were made, using an electric inflammability furnace (see *Proceedings* N. F. P. A., 1915, page 133). Five panels of untreated yellow pine air dry were tested, five kiln dried, and seven after creosoting. Of the latter, five were tested 7 months after treatment and two 18 months after treatment. The creosoted pieces took approximately 30 pounds of creosote oil per cubic foot. The panels tested were all yellow pine and were all cut from the same board. All panels were subjected to the heated plate, the temperature of which was 450° C. (842°F) for six minutes after ignition and then moved to the back of the apparatus where they were allowed to remain six minutes longer. The results are given in the following table:

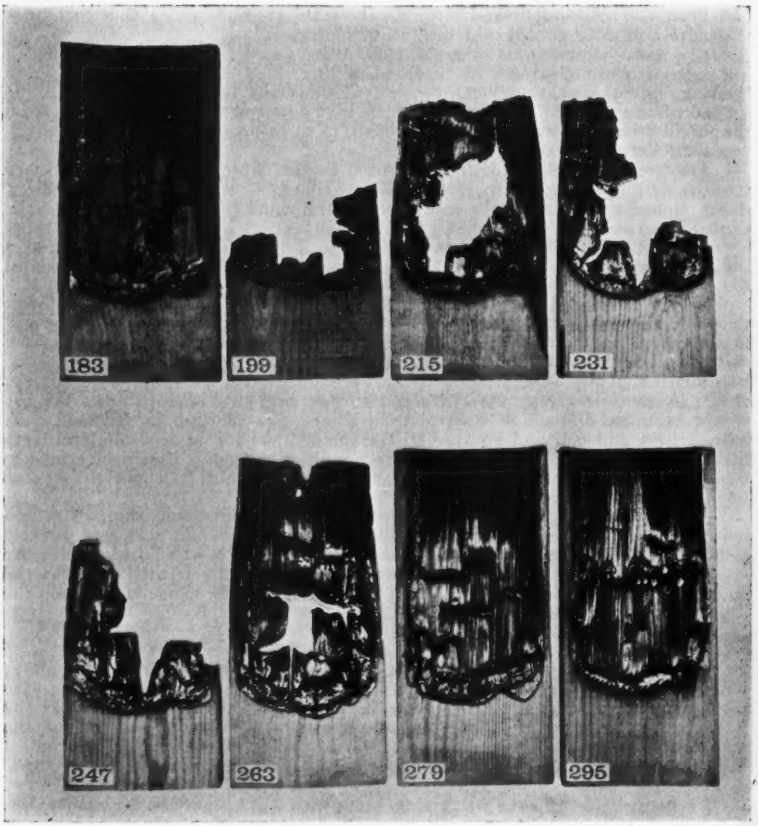


Fig. 2. Untreated southern pine panels tested in electric furnace, showing destruction by fire.

Untreated Air Seasoned.

	No. 1	No. 2	No. 3	No. 4	No. 5
Ignited and burned freely after	1m. 50s.	2m. 50s.	2m. 50s.	2m. 50s.	2m. 50s.
Out after.....	8m. 0s.	15m. 0s.	17m. 0s.	16m. 30s.	40m. 0s.
% lost by weight..	8.6	16.8	21.1	17.0	52.2

Untreated Kiln Dry.

	No. 1	No. 2	No. 3	No. 4	No. 5
Ignited and burned freely after	2m. 10s.	0m. 40s.	1m. 0s.	1m. 40s. Put out	2m. 0s.
Out after.....	15m. 10s.	23m. 15s.	24m. 0s.	25m. 40s.	16m. 45s.
% lost by weight..	20.4	55.7	56.6	55.5	23.7

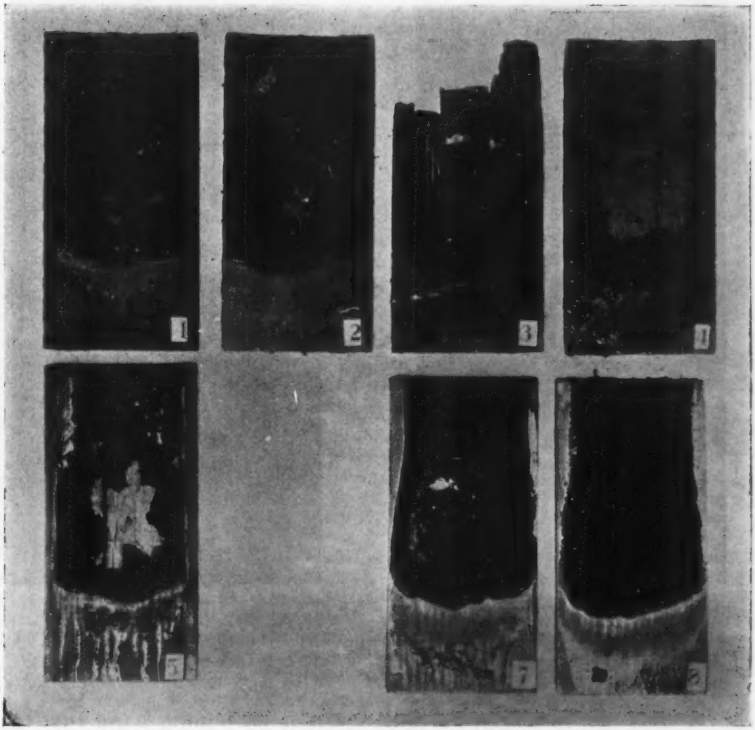


Fig. 3. Creosoted southern pine panels tested in electric furnace, Nos. 1 to 5 after 7 months, and Nos. 7 and 8 after 15 months. Panel No. 6, missing from the photograph, was lost.

	Creosoted.						
	After 7 months					After 15 months	
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 7	No. 8
Ignited and burned freely after...	4m. 10s.	6m. 10s.	7m. 30s.	5m. 40s.	5m. 40s.	8m. 0s.	4m. 10s.
Out after...	18m. 30s.	25m. 40s.	31m. 30s. Put out	24m. 0s.	22m. 20s.	22m. 40s.	20m. 30s.
% loss by wt.	17.2	20.4	44.4	19.3	15.1	17.0	18.5

m=minutes.
s=seconds.

A study of the figures indicates very clearly that the creosoted pieces resisted ignition two to three times as long as did any of the untreated pieces. After they once had become ignited, however, they burned fiercely. One of the panels had to be put out after burning 31 minutes. It will be noted, however, that one of the untreated

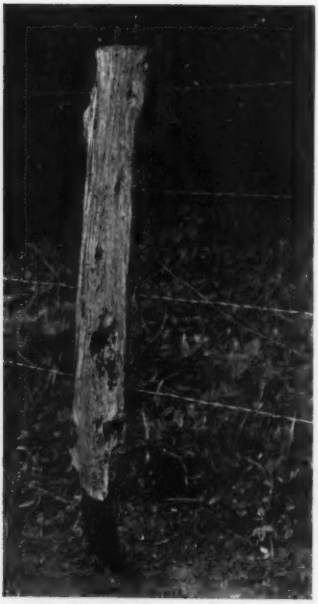


Fig. 4.

Fig. 5.

Showing respectively an untreated cedar post, with typical method of burning off at the ground line, and a butt creosoted sycamore post, a typical example of butt treated posts—service 13 years.

pieces also had to be put out after burning 25 minutes, and that the loss of the untreated panel was higher than that of the creosoted panel. The conclusions drawn from these preliminary determinations were that creosoted timber after drying about six months is much less inflammable than similar timber in an untreated condition.

Results from Practical Experience.

The conclusions just referred to confirm the results of practical experience during the last 20 years or more. On many of the railroads creosoted fence posts have been used for some years. Untreated posts were mixed with creosoted posts in certain test sections. The untreated posts were either white oak or cedar. The creosoted posts were of all kinds of wood, sycamore, beech, red oak, cottonwood, elm, etc. One of the chief difficulties with the untreated posts is that they very frequently burn off at the ground line, or to speak more properly "glow" off. Weed and grass fires running along the ground set fire to the more or less punky wood found at the ground line of a fence post after several years' service. This wood glows and after destroying the partially decayed wood, continues through the sound wood, with the result that the posts are gradually burned off and hang suspended from the wires. This is one of the common

sights along practically every railroad in the United States. In order to test the relative resistance of the creosoted posts to this kind of action, the test sections just referred to were constructed. Figures 4 and 5 show two posts, one the usual cedar post and the other a sycamore, which is given as typical of all the creosoted posts. These posts have been in position for about 13 years, and all of the creosoted posts are in as perfect condition as when they were first placed, while many of the untreated posts have burned off. In presenting these photographs, it should be remembered that the inflammability of cedar can be directly compared to the other woods, because they all ignite, particularly at higher temperatures, at about the same point (See *Proceedings* N. F. P. A., 1915, p. 148).

The results obtained with the creosoted fence posts have furthermore been confirmed by the history of creosoted telephone and telegraph pole lines. The writer is indebted to the officials of the American Telephone & Telegraph Company for the following report on poles on line between New Orleans and Mobile, made in 1906:

The Montgomery-New Orleans Line was constructed in the fall of 1899. It contains about 7,650 creosoted round yellow pine poles, the majority (6,507) of which are 25 feet in length. The majority of the short poles are of shortleaf yellow pine. The poles were treated during the spring and summer of 1899 under the direction of the A. T. & T. Company at the West Pascagoula, Miss., Creosoting Works, with 12 pounds dead oil of coal tar per cubic foot of wood.

In November and December, 1906, an inspection of the creosoted poles of this line was made by the A. T. & T. Company, New York Engineering Department. The poles inspected cover the section between poles 6348 (near Hurricane, Ala.) and 5710 (Magazine, Ala.), the poles of the Mobile Loop and poles 7106 (near Dog River, Ala.) and 8421 (Scranton, Miss.)

Owing to the conditions encountered in the building of this line, special construction was necessary. This consists of "Pile," "H" and "Tripod" fixtures, poles braced in four directions, etc. Many of the poles were set in swamps and permanent water where grass and reeds grow to a height in some cases of nearly twenty feet. The reeds and grass when dried out catch fire and crack the glass insulators and anneal the copper wires in certain sections. In the total number of poles examined is included each separate pole, brace and stub in the various fixtures. In the figures given below, each pole, brace, stub and pile is counted as a piece, and hence the number of pieces reported is in excess of the number of poles and fixtures inspected. The section of line inspected was built during August, September and October, 1899, and the poles had accordingly been in service about seven years.

The inspector reported as follows:

"2152 pieces examined,
11 slightly burned,
3 badly burned.

"As compared with untreated poles, I would say that fire has little effect on creosoted poles. From all appearances, many of them had been exposed to a fierce blaze, yet three out of fourteen are burned seriously enough to consider dangerous (to leave in the line). A fire to burn up debris from the storm of September, 1906, was kindled near these three poles, and spread to some large saw logs (pine) and pine tree trunks that were in contact with them.

"In the other eleven cases the surface coat of tar is burned off and the surface of the pole blackened and slightly charred. Some of the juniper poles in the telegraph line paralleling this line and exposed to about the same conditions have suffered to a greater extent."

In 1915 a re-inspection was made of this line, a complete report of which was presented by Messrs. Rhodes and Hosford at the 314th meeting of the American Institute of Electrical Engineers October 19, 1915. Of 1,598 pieces inspected 7 poles are noted as having been removed because of damage by fire. Incidentally, it is of interest to note that 8 poles had been damaged by storms. In other words, in 16 years 7 poles out of 1,598 had been damaged sufficiently by fire to necessitate their renewal. This is a record which is far superior to any similar record available for untreated poles and shows very clearly the high resistance to fire of these creosoted poles.

Another report from the American Telephone & Telegraph Company described the effects of the Jacksonville fire in 1901. About thirty creosoted yellow pine distributing poles were exposed to the fire near the post office. Of this number, four had to be replaced. In no case was the charring into the pieces more than one-half inch deep, except where some metallic object was attached to the pole. The oak pole steps, which were untreated, were in many cases burned off. That the fire to which these poles were exposed was an extremely hot one was shown by the fact that the brick pavements at their base were cracked and pulverized. The engineer who made the inspection said: "It was a curious fact that these poles withstood the fire better than any brick wall in Jacksonville."

The foregoing instances might be greatly multiplied, because similar experiences have been obtained by other pole-using companies.

Another set of interesting data was recently obtained with reference to the inflammability of creosoted yellow pine wooden pavements. In 1914, pier 36 of the Philadelphia & Reading Railroad was destroyed by fire. "The fire was so hot that a large portion of the structural steel was fused and the whole pier shed was destroyed and the greater portion of it thrown down on the wood block floor. After the removal of the debris, it was found that the wood blocks which had been directly subjected to the flames were only charred from ⅛ to ¼ inch deep, but where the fused structural steel had come into direct contact with the blocks, they were charred from ¾ to 1 inch deep. In the reconstruction of the pier, it was found that it would only be necessary to remove the charred surface of the blocks, and this was done by scraping, but at point where deep scars had been made by the contact with the steel, the blocks were removed, turned upside down and relaid." It should be stated that all this wood block paving had been laid on a concrete base. Experience elsewhere has shown that where creosoted wood block paving is laid in this manner, the fire hazard is practically negligible.

Large quantities of timber, particularly of southern yellow pine and Douglas fir, have been used for the construction of bridges. When this class of material was first used, most of the bridges were so-called open deck structures. A good many of these bridges burned either because of cinders dropping on to the structures from locomotives, or more frequently because of rubbish fires under the bridges. A good many of the railroads then began to place planking between the bridge ties, so as to form a continuous deck. The entire deck

was then covered with several inches of ballast. This practice immediately reduced the number of fires. This method of construction soon gave way, however, to the building of what has come to be known as ballast deck trestles. In these a solid deck is built on which the ballast is placed, effectively covering up all the creosoted timber. Those railroads using ballast deck bridges report the very best success. Interesting data as to practice in this regard will be found in the *Proceedings* of the American Railway Engineering Association, volume 14, pages 690 to 697, 1913. Further data with reference to this same matter will be found in a paper by H. M. Rollins, in the *Proceedings* of the Sixth Annual Meeting of the American Wood Preservers' Association, pages 33 to 36, 1910.

Realizing that creosoted timber has some fire risk, various methods have been suggested for reducing the hazard. For open deck bridges it has been the practice to cover caps and sills with sheets of galvanized iron. The Pennsylvania Railroad reports: "On the division in which the tops of caps and stringers are covered with galvanized iron, projecting one inch over the sides, there is a 75% decrease in fires on bridges so protected." The Delaware, Lackawanna & Western Railroad after a severe bridge fire near Paterson, adopted the standard recently of covering all exposed creosoted bridge parts (in cases where freshly creosoted timbers are used) with neat cement, and reports that this method has given very satisfactory results.

In addition to the foregoing, there are at present on the market a number of patented fire-resistive paints.

Summary.

Summarizing the foregoing, it appears that creosoted timbers when freshly treated are highly inflammable, due no doubt to the giving off of gases of a highly inflammable nature. As the creosoted timber ages, there is a marked reduction in inflammability, until after five or six months it will have the same degree of inflammability as untreated timber, and from then on becomes less inflammable. The reason for this is that the high flash point of the oil usually used requires a very high initial temperature to set the same on fire. This is particularly true of the oils used at the present time, the flash point of which is about 280° F, whereas the oils used some years ago had a flash point of about 210° F. As the oil evaporates, the compounds left in the outer layers on the outer surface of the wood require an increasing temperature to set them on fire. As was well stated by Mr. Rollins, "Just as this coating increases, the inflammability of the timber decreases, and finally, when all vaporization has ceased, the timber is in a measure fire-proofed by the coating. It is, however, possible to ignite the timber even after this coating is formed, but it does not ignite as easily as the same kind of timber untreated and in the same state of dryness."

After a creosoted stick of timber starts to burn, it appears to burn fiercely, making a large amount of black smoke. After the fire has gone out, it will be found that a surprisingly small amount of charring has taken place, due doubtless to the fact that the heat gen-

erated by the burning of the outer layers causes the creosote oil to be fed from the inside of the stick very much after the nature of a wick; in other words, the oil burns, but the amount of heat developed is largely used up in vaporizing the oil, leaving the wood more or less protected. This has frequently been experienced on burning bridges, where the creosoted stringers have caught fire. After the fire the stringers were found to be charred, but they had been only slightly weakened, and in many instances were still able to hold up the structure. This was well illustrated in a recent fire on the McKinley bridge, St. Louis, where the unprotected roadway caught fire. The fire was communicated to the creosoted stringers supporting the roadway. The fire burned fiercely for an hour or so, until it was put out by the fire department. An examination made by the writer after the fire (see *Engineering News*, March 1, 1917) showed that many of the stringers were charred for about one-fourth inch, but still held the roadway. Many of the steel plates were buckled so badly that they were wholly useless.

Based on the results of both theoretical and practical experience, it may be said that creosoted material when used with proper design is somewhat less subject to ignition, consequently it can be regarded as a safer risk than untreated timber. One additional reason for this is that the untreated timber, particularly if it has sapwood, starts to decay, and the punky decayed timber offers a good point for starting a fire.

Fires At Creosoting Plants.

As was stated at the outset, the number of fires which have occurred at creosoting plants is remarkably small, considering the present extensive nature of the industry. Most of the fires that did occur took place in plants of more or less ancient design. With the proper understanding of what constitutes fire hazard at the present time, it is not surprising that fires at plants during recent years have practically not occurred. As was well stated by Mr. J. G. Hubbell, Manager of the National Inspection Company, in a paper entitled, "Fire Prevention and Protection as Applied to Wood Preserving Plants," presented at the annual meeting of the American Wood Preservers' Association, 1918: "This question resolves itself into two points, (1) fire prevention and (2) fire protection." Mr. Hubbell calls attention to the fact that the first factor in fire prevention is orderliness and dwells on the necessity for a clean plant and yard. As stated in his conclusions: "I believe that more fires are prevented by the broom, the rake and the use of brains than are put out by any amount of fire apparatus that can be accumulated." Most modern wood preserving plants have thoroughly appreciated this suggestion, and the most careful attention is being paid to the arrangement of the yard, the absence of rubbish, and general cleanliness.

A partial list of the fires which have been reported to the National Fire Protection Association since 1909 may be of interest.

H-12621. Texarkana, Ark., 1909.—Total destruction of creosoting plant of wood construction, due to carelessness of boiler maker in leaving torch in dark retort room. Inflammable trash was ignited thereby. Theoretically, presence of creosote accelerated the action of the fire, but it was conceded the result would have been the same had there been no creosote present.

H-12621-A. Texarkana, Ark., 1910.—Second fire in plant of above company, which had been rebuilt of concrete after destruction of plant in 1909. Explosion in a creosote working tank adjacent to the machinery room blew off manhole cover in top of tank, and a sheet of flame and creosote oil was ejected, the oil being spread over an area of half an acre, falling upon the plant buildings, three working tanks and a pile of timber. The burning oil was consumed in ten or fifteen minutes, doing no damage to the steel and creosote buildings. The timber thus sprayed with creosote oil was rapidly consumed. The value of the same was about $1,600. The explosion was caused by an electrical short circuit through the gauge wire inside the tank at a time when the work of forcing back the hot creosote oil into the working tank after completing the treatment of a charge was in progress. The superintendent had carelessly attached an electric light to the brass indicator chain, and a live contact was somehow made. The gas formed by the hot oil coming from the retort furnished the condition favorable to the explosion.

H-3655. Greenville, Texas, Feb. 8, 1909.—A group of frame, composition and gravel roof buildings of approximate area of 15,000 square feet, all machinery, boilers, impregnating cylinders and fire pump under one roof, with no cut-offs. Three steel creosote tanks with metal tops and screwed manhole in top, capacity 150,000 gallons each, located adjacent to each other, two within three feet of main building and one within thirty feet.

At the commencement of the fire, No. 1 cylinder was empty, Nos. 2 and 3 were full of ties which had been treated and from which the surplus creosote had been withdrawn. In No. 4 cylinder the process of impregnation was in process and creosote was being forced into the cylinder. While this was being done, the night engineer noticed a leak at a plug in the check valve on the discharge line of the creosote pump. He shut down the pump and commenced to force the oil out of the cylinder and endeavored to tighten up the plug, when it blew out. The engineer then proceeded to the header and released air pressure, when pump room immediately burst into flames. The engineer then changed the water supply to the fire lines and left the building.

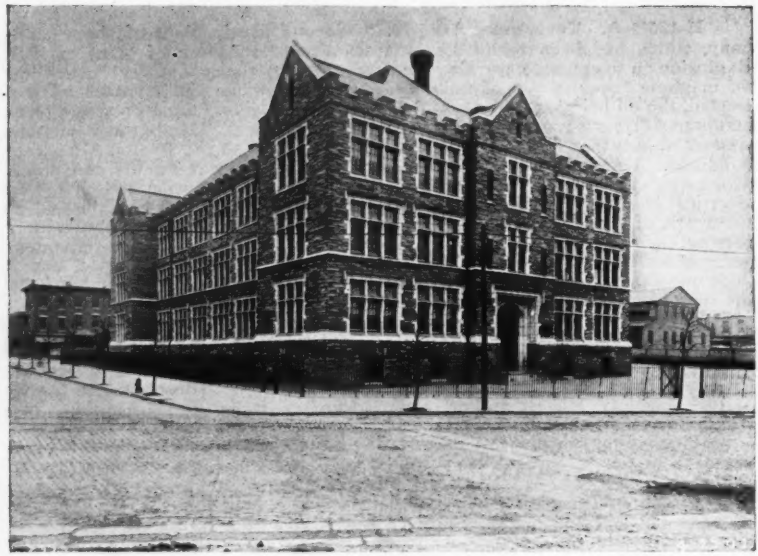
The exact origin of the fire was unobtainable. The plant was lighted by electricity generated by its own dynamo, but the equipment was utterly destroyed, so that it is impossible to tell whether defective wiring was responsible. It was stated that no oil lanterns were used about the premises.

The fire spread with extreme rapidity and quickly involved the entire premises. During the early stages the heat caused the 10-inch supply pipe from the creosote tanks to rupture and the oil poured into the building, adding fuel to the flames. The creosote inside one tank only ignited and burned freely and through the manhole in the top. There was no explosion. The duration of the fire was about five hours, at the end of which time everything combustible had been consumed.

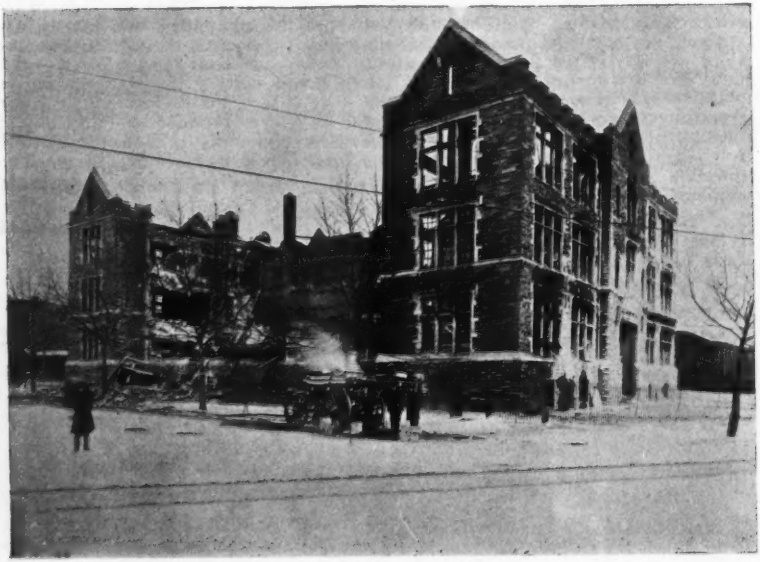
H-5682. Pascagoula, Miss., 1910.—Spark from passing locomotive ignited refuse in yard of plant. Fire communicated to the treated poles in yard. Loss on stock and derrick, $7,000. No loss to buildings.

H-6833. Berkley, Va., 1911.—Fire started in the boiler house, due to boiler stock igniting roof woodwork. Loss, $5,233.46.

H-9226. Linnton, Oregon, 1913.—Gasket blew out in pipe line, conveying creosote vapors to condenser. Vapor ignited from boiler twelve from break. Loss, $9,000.



Brooks School, Philadelphia, before fire.



Brooks School, Philadelphia, after fire.

Department of Fire Record.

School Fires in Philadelphia.

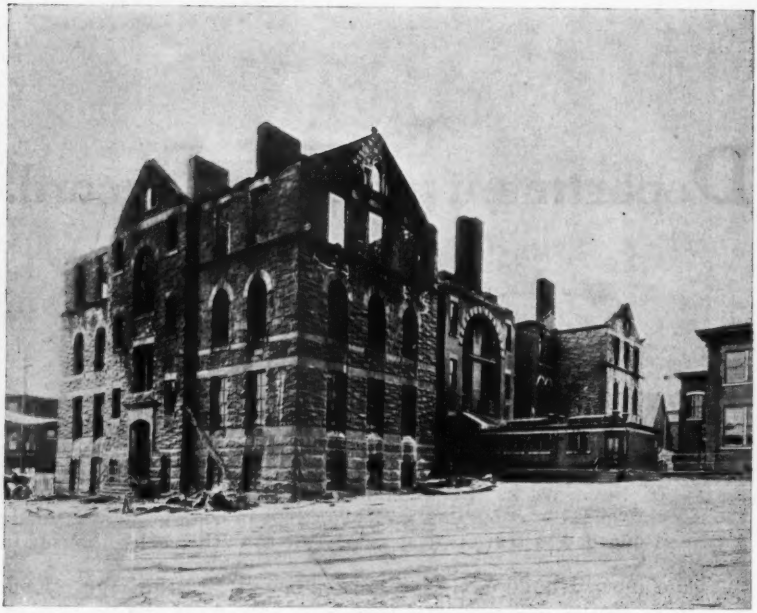
January 9 and 23, 1918.

Special Report by William McDevitt, Chief Inspector, Philadelphia Underwriters' Association.
(Member N. F. P. A.)

The recent destruction of the Heston and the Brooks Public School buildings located in a particular section of the city in adjoining school districts, and the separate fires occurring within a period of three weeks, each attended with similar circumstances, caused considerable comment, and before an investigation was made a citizen guard was stationed at nearly all the other schoolhouses in the city.

The burned buildings were erected about 17 years ago. Each was three stories in height and they were somewhat similar in plan, being rectangular, U-shaped, the ground areas being about 11,000 square feet. Exterior walls were of granite, 24 inches thick, interior being walls of brick. Inside partitions were all of wood and plaster. Both buildings were built before the adoption of fire-resisting construction for schoolhouses. Both buildings had fire tower escapes, were heated by steam and lighted by electricity.

The buildings had been closed some hours before the fire by the respective janitors after the fires had been banked for the night and cleaning up done, leaving the structures without any protection. The janitors, living in the vicinity of the schools, were notified of the fires in each case by passers-by who saw the evidence of fire in the buildings. The janitors proceeded to and opened the buildings, and along with others saw the fires in each case burning on the first floor. The fires spread so rapidly as to baffle any check with means at hand. The alarm was promptly given, and by the time the first complement of firemen arrived, the flames had extended throughout the interior of both structures, and each being located on the corners of large streets, and with clear space all around, afforded good draught to the fires, resulting in a complete destruction of the interior of both structures. With the Heston building the walls remained standing, but during the fire at the Brooks, while a number of firemen were directing streams into the windows of one of the fronts, a section of the wall fell out on the men, killing three outright and causing the death afterwards of two others from injuries.



Heston School, Philadelphia, after fire.

In the investigation, the steam heating apparatus located in the basement was found to be clear of all blame for the fire. The sale of Thrift Stamps had been recently introduced in all the public schools. The stack of stamps and money derived therefrom were in charge of the principals of the different schools, and it was the custom to keep the stamps and money in the principal's room. Previous to the recent fires several school buildings had been broken open (supposedly by boys), and in some cases stamps and money taken. As the fires in both burned buildings were first seen in the principal's room, it is believed that the recent fires resulted from a like motive. The intruders, being cautious not to turn on the electric lights, used matches in the search, and in their hurry caused the fires among the papers lying around.

The burned buildings were erected at a cost of $95,000 and $80,000 respectively.

In our long experience in investigating fires originating in school houses, occurring either during the day or night, a remarkable feature in the inquiry was the absence of the janitors when the fires were discovered, and nearly all the outbreaks would not have occurred if a watch system had been kept in the buildings, particularly during the presence of the children, a condition that demands as much, if not more, care and guard against fire or panic than are kept over adults composing theatre audiences.

Fig. 1. Burned section of Vassar College after the fire.

Vassar College Fire.

February 12, 1918.

Special Report by Underwriters' Association of New York State, R. G. Potter, Secretary
(Member N. F. P. A.)

Fire occurred at Vassar College on February 12th, 1918, at approximately 6.45 p. m., starting on the fourth floor of the easterly wing in the section occupied as maids' rooms, and apparently near the southeast corner of this wing.

This building was located between the main building and fire-resistive kitchen, and was of ordinary hollow joisted brick construction, with lath and plaster walls and slated mansard roof. It was occupied in basement for store room, first floor for store room, second floor for dining room, third floor for assembly hall, fourth and fifth floors for maids' and helps' sleeping quarters.

The fire was discovered by a maid, who broke the private alarm box on the fourth floor, registering an alarm in office and starting the fire drill gong throughout the building. All students and help were at dinner and marched out in order without panic or disturbance. A watchman with clock was employed nights, but had not as yet turned in his nightly round.

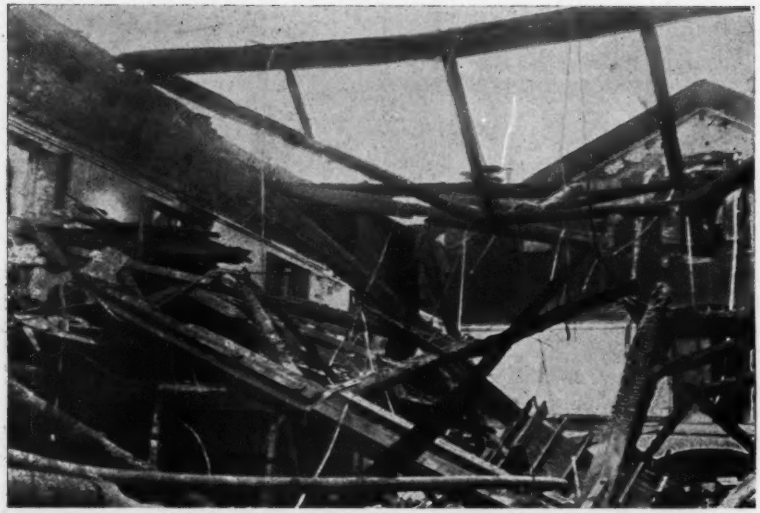


Fig. 2. View from interior of Assembly Hall, Vassar College, after the fire.

The cause was a defective flue in the wall from charcoal steak broiler in kitchen. About one hour before the fire was discovered, it is reported that the rooms on the fourth and fifth floors were full of smoke, which upon investigation proved to be smoke from the charcoal broiler in the basement. This, however, was believed to have been circulated outside the building and in through the windows.

A general alarm was promptly sent in over the telephone. Private hose lines were laid out from the standpipes in the main building. Private fire pumps were at once started up, two hydrant lines run from hydrant near laundry on the northeast side of the wing and six inside hose lines laid from the main building. A steamer of the Poughkeepsie Fire Department was stationed at hydrant near Strong Hall, from which were laid two lines, and a 700-gallon triple combination stationed at the lake about 1250 feet away laid in one line of 1200 feet expanded to two lines of 300 feet each.

The fire was held in check at the division wall between the buildings, which is provided with poor tin-clad door on the fifth floor, with wood doors or open arched openings on all floors below. The slated mansard roof fell in, crushing through the fourth floor and blanketing the fire on the third floor, about one hour after the fire started. Fire was apparently safely under control by about 9 o'clock, and the engines shut down at about 10 o'clock. The Fire Department was on watch throughout the rest of the night.

At about 8 o'clock it was necessary to shut down the large fire pump at the College Avenue station and turn the same into the service system, as the service tanks of North Hall supplying water heaters,

etc., were practically empty, and this pump was not on the fire line for 45 minutes.

In all, about nine lengths of hose burst, mostly the unlined linen hose of the private department.

The sound value of the main buildings including this is approximately $500,000, and the contents $40,000. The loss on buildings will be approximately $85,000, and on contents approximately $20,000.

The principal point of interest is that the loss was restricted to such a small percentage of the entire area and value, there being no real cut-off, as the slated mansard of the wing exposed the frame cupolas of the main building over the fire wall, and the latter had unprotected openings all the way below the fifth floor. This result was due in large measure to the fact that the fire started on the top floor and burned out through roof supports. The falling slate roof blanketed the fire to a great extent, and there was no wind.

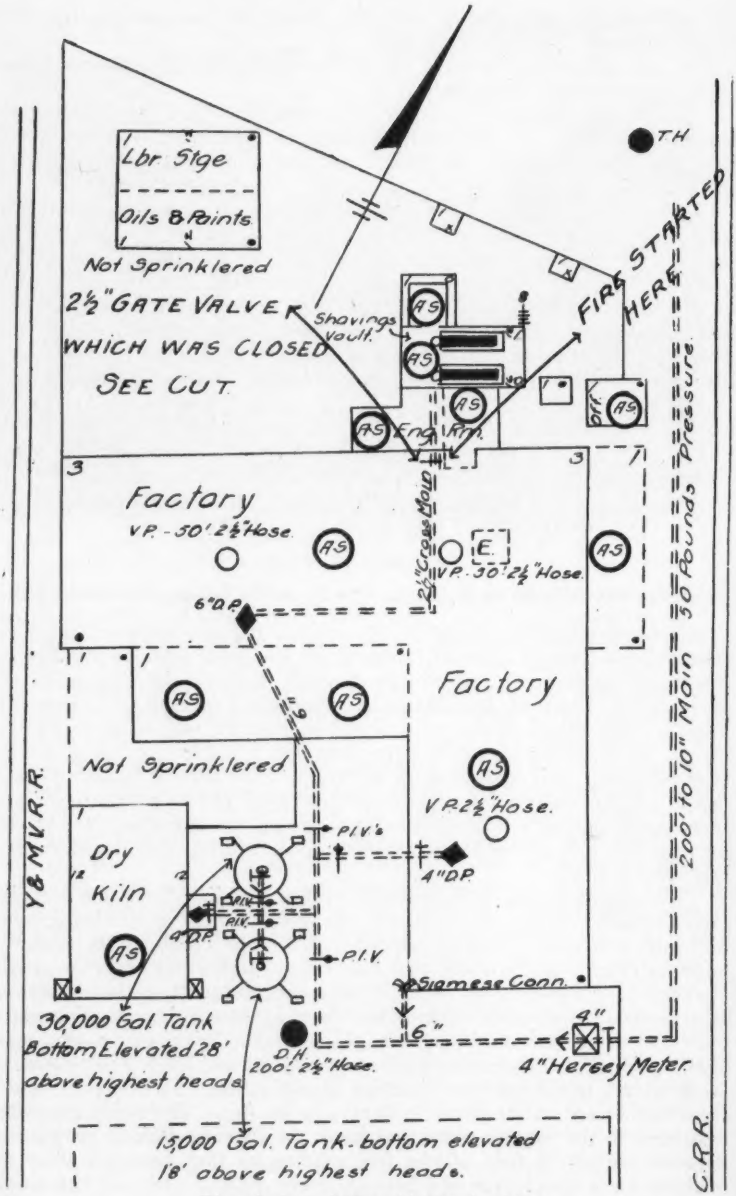
Memphis Furniture Company Fire.

February 13, 1918.

Special Report by Tennessee Inspection Bureau, F. B. Quackenbos, Manager, (Member N. F. P. A.)

Summary.—Fire of unknown origin, though believed to have started in a pair of overalls hanging on the west wall of the Engine Room, completely destroyed the Factory and Engine Room of the sprinklered plant of the Memphis Furniture Company (Tennessee Plant). The alarm of fire was turned in from an adjoining plant over the T. D. T. system at 6.46 p. m., but the fire department was slow in responding as it was at work at another fire several blocks distant. Seven engine companies responded and used eleven streams of hose from pumping engines, which had practically no effect on the burning factory though of valuable assistance in saving the dry kiln and lumber yard.

The factory was a three-story frame building of quick burning construction and was occupied for the manufacture of furniture. The building contained a large amount of highly combustible material such as veneering, varnish, and kiln dried lumber. The fire was discovered in the engine room in its incipient stages by the watchman, who became very much excited, and instead of turning in a fire alarm over the approved auxiliary fire alarm boxes with which the plant was equipped, and then using the standpipe and hose equipment, he went to the telephone and (instead of asking for "Fire Department") informed "Central" that the factory was on fire. **The watchman then returned to the engine room and blew the factory whistle which was located within 15 feet of the fire. After he had been blowing the whistle for a short time the first sprinkler head fused and the smoke drove the watchman outside.**



Plan of plant of Memphis Furniture Co.

The reason why the sprinkler equipment did not extinguish the fire in its incipient stages was that a 2½-inch gate valve in the cross main supplying sprinklers in the engine and boiler room was almost entirely closed. After the fire an inspector uncovered the valve in the ruins (see photograph herewith) and the gate was found to be open only seven thirty-seconds of an inch, which was not sufficient to supply the 16 sprinkler heads in engine room where the fire started.

The engine room was of light frame construction and when the fire burst through the light frame wall into the three floors of the factory it is believed that nearly all of the sprinkler heads (about 732) were opened by the flash fire. The area of discharge orifices of 732 sprinkler heads is 143 square inches, while the combined area of the 4 and 6-inch dry pipe valves is only 41 inches. With the orifices in sprinkler heads three and one-half times larger than the dry pipe valves it is evident that the primary water supply (a 4-inch City connection under 50 pounds static pressure) and 15,000 and 30,000 gallon gravity tanks elevated 18 feet and 28 feet above the highest sprinkler heads could not supply sufficient pressure at sprinkler deflectors to properly cover joisted ceiling areas.

The sprinkler system apparently had no effect on the fire, for even with the assistance of eleven streams used by the fire department the building burned to the ground. A close examination after the fire of the water supplies, and water flow tests made through the dry pipe valves indicated that the valves tripped properly. The gravity tanks were said to be full before the fire (though both were empty after fire) and on examination everything was found to be in proper working order except the 2½-inch closed gate valve supplying sprinklers where the fire started.

Statements of Persons First Arriving at Fire.

Jesse Robinson, night watchman, stated that he was 39 years of age and had been employed as night watchman at the plant since October, 1917. Previous to that time he was employed for sixteen months as watchman at a plant in Jackson, Tenn. In addition to his duties as watchman he was required to maintain fires under boilers at night, also to see that all employees registered out on the time clock at night. His duties did not require him to inspect fire appliances other than to examine post indicator valves to ascertain if they were open and to note if the proper air pressure was maintained on dry pipe valves. Beyond these duties he was not familiar with the sprinkler equipment.

On the night of the fire in question he reported at the plant for duty about 5.45 p. m. and went into the engine room and hung his vest and shirt in a wood locker in the southwest corner (approximately where fire started) and put on his overalls, took his coal oil lantern out of the locker and went out into yard and lighted same. Then he went out on the platform and saw all employees register out. At about 6.10 p. m. he went through the factory and around to the boiler room to bank the fires and remained there until 6.30 p. m., his usual time for reporting to first T. D. T. box. He pulled two boxes on the first and second floor of the factory (T. D. T. records indicate

that the rounds were received at 6.30, 6.32, 6.34 and 6.36 p. m.) He then went to the third floor to pull box at this location and noticed smoke coming up through the elevator shaft. He looked down the elevator shaft and saw a reflection of light coming through the glass window of the engine room. He went to the office on the first floor and telephoned "Central" that the factory was on fire, then went into the engine room and tried to secure his clothes but could not reach the locker as fire appeared to be coming out of it. He noticed a pile of rags burning on the floor near the west wall (see statement of engineer about hanging overalls on wall at this point), but did not notice the rags on the floor at his first visit to the locker at 5.45 p. m. Being unable to reach his clothes he went to factory whistle (located about 15 feet from fire) and continued to blow the whistle until the sprinkler head over the fire fused and the smoke drove him out of the room. He then called assistance from an adjoining plant.

When questioned as to why he did not send in fire alarm over the T. D. T. boxes the watchman stated that he was very excited. Watchman also stated that he was not aware of the existence of the 2½-inch closed gate valve that was responsible for the fire getting beyond control of sprinklers.

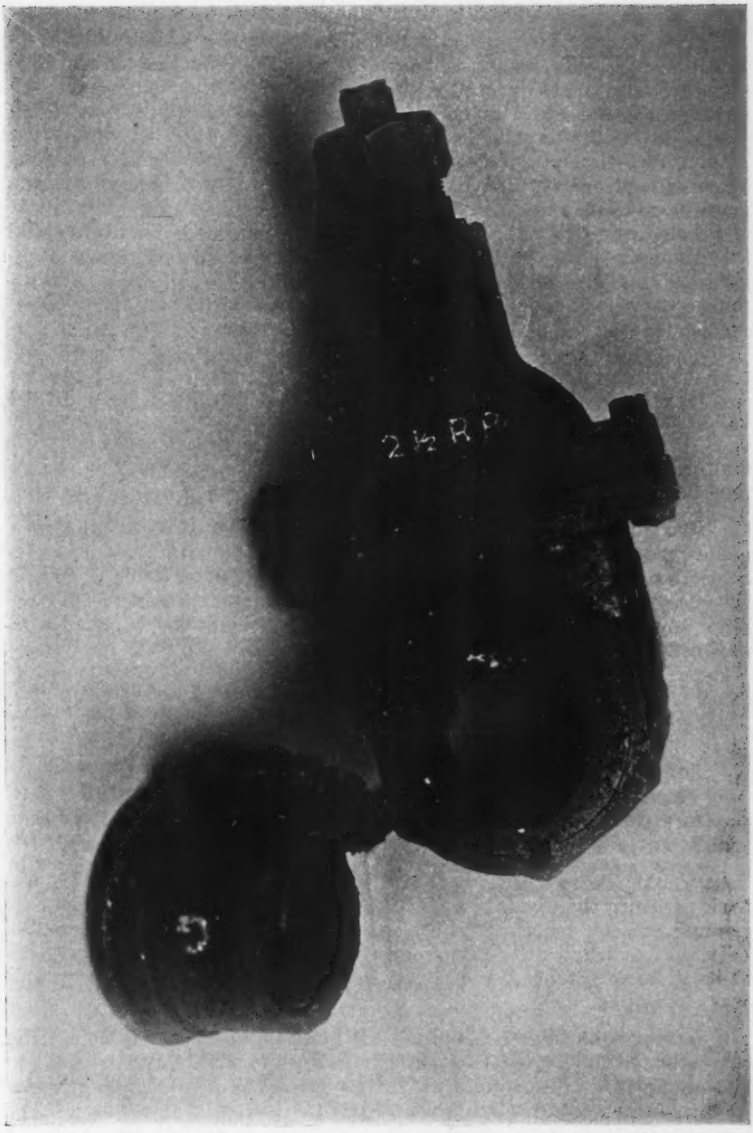
D. W. Bishop, superintendent of plant, stated that he left the plant at about 6.10 p. m. and went home, which is about seven blocks distant. A neighbor informed him that the plant was on fire. He returned immediately and went direct to the engine room window and noticed that the room was full of smoke. He then went through first floor of the factory to examine post indicator valves to ascertain if they were open and found them all indicating open. There was no fire in the factory when he passed through. He then went outside and met the firemen and directed them the best way of laying hose around plant.

E. Martin, engineer of plant, stated that he left the plant about 6.30 p. m., and before leaving hung his overalls on the west wall of engine room (watchman stated that rags on floor were burning at this point). He had charge of the sprinkler system and maintained the system dry throughout the year. He had tested all alarms and valves the day before the fire and everything was then in good working order. He filled the large tank every night as this was also used for domestic purposes around the plant. The systems were set dry at time of the fire **and he tested the 2½-inch gate valve supplying heads to engine room the day before the fire and it was open. This valve had not been closed for a year.**

Construction.

Factory: Height, three stories, L shaped; size, 60 by 160 feet and 55 by 100 feet, of quick burning frame construction with partly protected floor openings and open joisted ceilings.

Engine Room: Located adjoining and communicating with factory on the first floor through frame doors. Height, one story; size, 18 by 40 feet of ordinary frame construction.



The closed gate valve which was largely responsible for the destruction of the Memphis Furniture Co.'s Plant.

Automatic Sprinkler Equipment.

Three source equipment installed in 1905; one 4-inch and one 6-inch dry pipe valve in first floor of factory. Pipe sizes were 1896 schedule with areas covered averaging 8 by 9 feet. Heads were obstructed by stock and machinery. Primary water supply was from public waterworks system with one 6-inch connection containing a 4-inch Hersey detector meter and connecting with a 10-inch main one block distant. This main is fed two ways by a good 10 and 12-inch gridiron system under 50 pounds pressure.

The secondary supply is from a 30,000 gallon steel tank on a 70 foot tower in yard; bottom of tank was elevated 28 feet above highest heads. Third supply of water was from a 15,000 gallon gravity tank on steel tower in yard with bottom elevated 18 feet above highest heads.

Test of Sprinkler Dry Pipe Valves After Fire.

In order to determine if there was any obstruction in the dry pipe valves or underground piping a water flow test was made through each dry pipe valve. A member of the Waterworks Department took readings through the Hersey detector meter to obtain the flow in gallons discharge each minute.

First Test: Gravity tanks were cut off and a water flow test made through the 4-inch dry pipe valve using the City pressure only. Static head 50 pounds. With the post indicator valve wide open and the meter registering a delivery of 400 gallons each minute the residual underground pressure was 20 pounds. This would have produced 2 pounds pressure on the highest heads.

Second Test: With the 6-inch dry pipe valve and City pressure. With the meter registering a flow of 475 gallons each minute the residual pressure was 13 pounds. This was just sufficient pressure to reach sprinkler heads on second floor.

Third Test: With both dry pipe valves open using the City pressure the residual underground pressure was only eleven pounds which was not sufficient to reach to the second story sprinklers.

Fourth Test: With both valves open using both the City and tank pressure the residual underground pressure was 28 pounds or 10 pounds pressure on the highest sprinkler heads. This was undoubtedly the condition of the maximum water supplies when the fire was at its greatest intensity and before the water in the large gravity tank was exhausted.

Remarks on Water Supplies: It must be borne in mind that the above water supply from public waterworks system was not equal to the above tests at the time of the fire on account of eleven streams from pumping engines being used from the mains.

Conclusions.

All the evidence submitted in the above statements secured from those first arriving at the fire determines beyond reasonable doubt

that the fire started in the engine room either in the wood locker or from the engineer's overalls hanging on the wall.

The exact origin of the fire will perhaps never be definitely proven, though it seems quite probable that the watchman lighted his coal oil lantern at the locker and carelessly threw the match aside instead of lighting the lantern in the yard as stated.

The circumstances attending the fire once more demonstrate that too much reliance is often placed on the value of watchman's service, and that when the real test comes at time of fire the human element often falls short of what is reasonably expected of it.

In this example we find a watchman apparently in the prime of life, only 39 years of age, and not ordinarily regarded as dead timber or relegated to the job of watchman on account of being physically unfit for other duties. We find him to be a man physically able to perform his duties in guarding the plant against ordinary intrusion, and to supervise its safety against destruction by fire, but not temperamentally qualified to act with cool, quick decision.

The investigation discloses that the watchman was impressed only with the importance of punctually reporting to his station boxes, as his records in this respect were excellent, and that his knowledge of the inside protection of the plant was of little value.

The plant was amply equipped with standpipes, hose, and water casks and pails, and from the fact that the watchman stood within 15 feet of the fire and resorted to the primitive method of blowing the whistle instead of applying first aid extinguishing methods is ample proof that this loss should not have occurred.

It is absolutely inconceivable that even an old or superannuated watchman could visit night after night the combined watchman and auxiliary fire alarm boxes with which this plant was provided and yet upon discovering a fire, instead of using this admirable equipment lose his mental faculties.

There was a standpipe within 35 feet of the point of origin of fire, and had the time expended in blowing the factory whistle been devoted to the use of this the fire would, in all probability, have been extinguished immediately.

The complete destruction of the plant was beyond question due to the closed gate valve supplying sprinklers in the engine room. This should be a warning to other plants that erect small unsprinklered additions, especially to frame buildings, that sprinklers under these conditions cannot be expected to stop exposure fires.

The water supplies at this property were a little above the average for a plant of its size and were ample to cope with any ordinary fire originating inside a sprinklered building. The results of the tests made from the City water supply through the 4-inch meter is a strong argument against connections to sprinkler systems of less than 6-inch size.

The gridiron system of 10-inch and 12-inch mains under 50 pounds pressure was undoubtedly a good water supply if a larger connection to sprinklers had been provided, but the low static head of 50 pounds did not produce sufficient velocity through the 4-inch

meter to cope with the large number of sprinkler heads that operated.

This fire is a vivid reminder that employers of watchmen should use due diligence and care in the training of them in the use of fire fighting appliances. It should be the duty of watchman to inspect all sprinkler valves and other fire appliances each night to ascertain if they are in condition to perform their proper functions in case of fire.

Every plant equipped with sprinkler systems should adopt a daily report blank to be filled out by the person having charge of the equipment. The report should indicate when all valves were last tested and other fire fighting appliances examined. Perhaps if this system had been in vogue at this plant the Memphis Furniture Company would still be in operation, and 135 persons would not have been thrown out of employment by the act of one careless person in closing the gate valve to the engine room.

Explosion and Fire in Tar Stills.

Mr. Benjamin Richards (Member N. F. P. A.) sends us a very interesting report of an explosion and fire connected with the manufacture of tar products. The explosion ruptured a still and set free 6,000 gallons of blazing tar. This flowed over a large area of the yard, threatening several buildings. The action of the employees in rescuing property was prompt and even heroic, and two men subsequently died of burns received. The superintendent was in the office building, some 300 feet distant, when he heard the explosion, and ran to the stills. Before he reached them a stream was already in use and the pumps going.

The employees had six streams in operation before the arrival of the fire department apparatus. The department ran one line of hose from a hydrant near the office. The effectual work in subduing the fire had already been done, however, and the fire was well under control before the department's arrival.

The boiler house was damaged, the thin glass windows in wooden frames here being burned and broken out, as was also the overhead coke conveyor in front of the stills. Besides this, a car of coke standing on the siding was completely burned, the car being destroyed. Sprinklers on the side of the boiler house toward the stream of burning tar opened, preventing the destruction of the boiler house. The open sprinklers on one building were put in operation and prevented damage to this building. The pump house south of the condensers, the belt to the pump and the cement office building near were damaged considerably.

As to the cause of the explosion which started the fire, only theories are available. That of the superintendent, a practical tar man of over twenty years' experience, is as follows: In the first place,

conditions, so far as the stills were concerned, were the same as are, and have been, in use for years without any previous explosion. One important difference, however, obtained. There had been for many hours a heavy downpour of rain, which continued throughout this experience. The stills in which the trouble started were a twin battery, the fire boxes under both discharging to a common flue or chimney separated into two compartments by a partial wall extending to about the level of the top of the fire chambers in the still settings. The stills were of ordinary triple rivet butt joint, boiler construction, the shells being ½-inch and the heads ⅜-inch steel plate. They were tanks without the tubing or inside bracing and with convex heads held in place by a single row of rivets, and they were not designed to carry any considerable internal pressure, each having a 2-inch lever safety valve set at 15 lbs. Besides this, there was an 8-inch opening reduced to 6-inch, 4-inch and 3-inch pipe into the condensers. This was open. There was also a 2-inch steam main (with ½-inch gauge connection), in which there was a cock and gate connected to the still and opening into it by a ¾-inch pipe. Both the cock and gate were shut and the gauge connection open. The safety valve was undisturbed, and according to a man standing on No. 2 still, the safety valve did not blow. At the time of the explosion, therefore, it is safe to assume that there was no internal pressure on still No. 3. The admixture of the distillates from tar are explosive when mixed with air in the proportion of from 7% to 13% vapor to 87% to 93% of air. Other mixtures are inflammable, but not explosive. No. 3 still was cooling, the fire box still containing live fire, and the fire box being at least red hot. Even admitting that No. 3 still was filled with an explosive mixture above the 6,000 gallons of hot tar which it contained, there appears no possible way in which fire could have reached it, and it is probable that an explosion inside the boiler would have ruptured the top or the top of the joint of head and shell. No. 2 still had just been charged with its load of coal tar (6,000 gallons), and the fires had just been started under it. Coal was being put on the burning kindlings when the explosion occurred. There was but one report, this being described as prolonged and rumbling rather than sharp and cracking, and it was followed by a roar as the hot tar flowed into the hot fire box, ignited, and then poured over the gravel. It is supposed that on account of the blanketing of the flue by the heavy rain gases from the new fire under No. 2 were forced into the hot fire box of No. 3, where the explosive mixture was ignited. The shell of the still appeared somewhat flattened in the lower third of its circumference, the forward head being forced outward and torn loose from the rivets through somewhat more than half the circumference, the plate itself being torn for an approximate distance of 2 feet, beginning on the lower right-hand side and extending upward and outward. The head remained in place on the upper part, still held by its rivets. It is supposed that the force of the explosion was primarily diverted upward under the centre of the still, partially buckling it and tearing loose the lower end of the head. The lines of force caught this loose edge,

ripping the head as mentioned, carrying out the fire arch and the 12-inch brick wall of the still setting in front. Toward the rear of the still the force and fire followed so close to the under side of the still as to pass over the rear baffle wall, where a pocket of gas in the bottom of the flue ignited, its explosive force being vented upward through the flue and forward toward the front of the fire box, blowing forward bricks of the baffle wall which were scattered toward the fire box.

The man who was firing No. 2 still was found in front of its fire box, the door nearer No. 3 being open. The man's condition from shock and burns was such that no information could be gathered from him. Whether the No. 2 fire door had been opened by the fireman for a coal charge or whether it was blown open by the explosion could not be learned. With the rupture of the still, its charge was emptied into the glowing fire box, where it was ignited, and expanded with such force as to be thrown some 70 feet in front of the still and some 40 feet to each side over a fan-shaped area. A man at work on a coke pile in the latter direction was spattered with the blazing tar. His clothes were ignited, and though he walked the 300 feet to the office, he succumbed to his burns on the second or third day, as did also the man found in front of still No. 2. This man was rescued from a stream of burning tar by men who risked their lives to accomplish it. One of the company's heavy gasoline-driven auto trucks stood in front of the Tarvia tanks something like 100 feet from still No. 2. The car was surrounded by the burning tar, but the chief chauffeur, while played upon by a hose stream, ran to the car, cranked the motor and drove the car to safety with the curtains blazing about his head and with fire licking the gasoline tank.

The stream of fire flowed down the railroad tracks past the open door of the pump room. The engineer opened one of the hose connections on the pump sufficiently to spray the door opening, and stayed by his pumps in the scorching heat and dense smoke. The work of these men cannot be too highly commended. Their grasp of the situation was instantaneous and their intelligent action but a thought less quick.

To lessen the danger of similar accidents in the future, it was recommended that each fire box be provided with a separate stack or flue, having no connection with any other.

Laboratory Explosion at a Tannery.

The hazards of the preparation of a particular kind of "dope" which, according to some accounts, is being manufactured at the present time in quite a few tanneries in the United States and Canada, are well brought out by the circumstances of a laboratory explosion and fire which have been reported by one of our members.

The laboratory was located at the north end of one of the buildings of a plant engaged in the tanning of "upper" leather. It was approximately 20x20 feet in area, with a small office adjoining. Three sides of the laboratory and office were composed of frame and glass partitions, the fourth side being the north brick wall of the building. The partition between the laboratory and office was also frame and glass. The small resistance offered by these partitions probably prevented the complete destruction of this end of the building. The force of the explosion completely destroyed the frame and glass partitions of the laboratory and office, the joists under the laboratory were all broken and the floor sunk 18 inches at the north end. The pressed steel ceiling of the laboratory and office was practically all down and the flooring above was blown off the joists. The joists above the laboratory were damaged by the explosion.

Some of the double windows were blown out and 240 panes of glass were broken. The entire contents of laboratory were practically destroyed.

Chemicals in Laboratory Previous to Explosion.

The laboratory was completely equipped for analyzing all leathers and all compounds entering into the manufacture, tanning and dyeing of leathers. Most of the chemicals were on shelves with plain edges. There were seven shelves in corner of laboratory where trouble originated, the two lower shelves being 10 inches, and the five upper shelves 6 inches, in width. The following chemicals were placed on these shelves as far as one of the members of the firm, who is a chemist, could remember.

On the two lower shelves:

One gallon bottle Acetone.
One gallon bottle Sulphuric Acid.
One gallon bottle Hydrochloric Acid.
One gallon bottle Nitric Acid.
One gallon bottle Acetic Acid.
One gallon bottle Ethylic Alcohol.
One gallon bottle Methylic Alcohol.
One gallon bottle Ether.
One gallon bottle Amyl Acetate.
One gallon bottle Glycerine.
One gallon bottle Petrolic Ether.

Fig. 1. Laboratory in which explosion occurred. "A B", "C", and "D" show former locations of frame and glass partition between laboratory, of picric acid, and oven containing 6 lbs. of gun cotton, respectively.

On the upper shelves:

One pound bottle Copper Sulphate.
One pound bottle Animal Charcoal (bone black).
One pound bottle Glucose.
One pound bottle Flour.
One pound bottle Collodion.
One pound bottle Collodion, Medicinal.
One pound bottle Tannic Acid.
One pound bottle Gallic Acid.
One pound bottle Phosphoric Acid.
One pound bottle Turpentine.
One pound bottle Oxalic Acid.
One pound bottle Silicic Acid.
One pound bottle Tartaric Acid.
One pound box glass wool.
Three one-pound boxes Asbestos Fibre, etc.

On the floor, under the lower shelf was one five-pound wooden box of picric acid. This box had a loose wood cover. Adjoining these shelves was located a galvanized iron oven (No. 22 gauge) with door equipped with substantial hinges and latch. This oven measured approximately 30 x 18 x 24 inches, was steam heated, and was used for drying

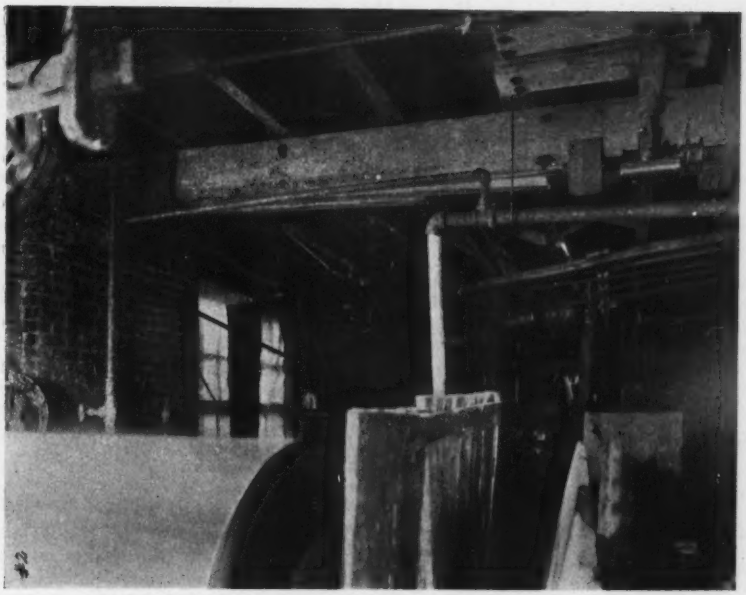


Fig. 2 Ceiling under laboratory. Note splintered floor joist, sunken floor and broken beam made of three thicknesses of 3 by 11-inch joist.

gun cotton. This oven was destroyed and must have been closed at the time of the explosion as the hinges and catch were torn off.

Possible Cause of Explosion.

The theory advanced by the chemist already mentioned was that one of the bottles on the upper shelves fell on some of the large bottles on the lower shelf, and that the compound of the chemicals in the bottles thus broken caused a blaze which exploded the gun cotton in the oven. If this was the cause of the explosion, the blaze must have been of very short duration, as it was not noticed by the numerous employees working in the vicinity of the glass partitions enclosing the laboratory. The vibration caused by shafting and machinery is very noticeable and would explain the fall of a bottle from a shelf.

The last round of the watchman was made at 6 a. m. and the central station records show that the box near laboratory was pulled at 6.03 a. m. The night watchman had no access to the laboratory, which was always locked when the chemist was absent. The engineer had a key and stated that he went in the laboratory between 7.15 and 7.30 a. m. on the morning of the fire, and did not notice anything unusual. He also stated that he did not smoke or carry any matches. The laboratory was locked at time of explosion as the chemist arrived a few minutes after the explosion.

Use of Gun Cotton.

The gun cotton was used to make a compound called "dope" used to dye and polish leather. The first process of mixing this compound was carried on in an unsprinklered shed located approximately 40 feet from the building. The mixture contained six pounds of gun cotton, six gallons of methylated spirits and six gallons of amyl acetate.

This compound was allowed to soak for half an hour and was then stirred. It formed a thick liquid which was taken to the first floor of the sprinklered building, in which the explosion occurred. It was placed in a revolving barrel and mixed with three gallons of castor oil, three gallons of benzine, three gallons of methylated spirits, and one-quarter pound Brilliant Black (German black soluble in alcohol).

The barrel was driven by belt from overhead shafting. One batch was mixed every week. After mixing, the solution was drawn off in cans and taken to the coating room where it was applied with brushes.

The stock of gun cotton (maximum 200 pounds) was kept in unsprinklered shed approximately 70 feet from building, was always kept in sealed cans, and contained 33 per cent. moisture. Only six pounds were brought in once a week to be dried in the laboratory oven and used in the above compound.

Further Investigations of Cause of Explosion.

The above report was submitted to a chemist of a local testing laboratory, who expressed the opinion that an explosion of the gun cotton took place, and further that as gun cotton can be exploded by percussion, it was possible that the fall of a bottle from one of the upper shelves, upon the oven, caused the explosion. It was also thought possible that the gun cotton used for tannery purposes might be of a grade below that used for the manufacture of high explosives and therefore less stable. It was further stated that gun cotton will decompose at 170 deg. F.

The picric acid was not believed to be the cause of the explosion, particularly after it had been ascertained that some of the crystals had been found on the floor.

At an investigation held subsequently, the manager stated that the temperature of the oven used for drying the gun cotton was regulated to 140 deg. F., and that the different lots of gun cotton usually remained in the oven for some 48 hours, the steam being turned off at the boiler at night and turned on again in the morning (about 7 a. m.). The gun cotton was placed in three removable pans, but there was no protection for the steam coils. The oven had been in use for some four months and had never been cleaned. A small table usually covered the oven, and the manager did not feel, therefore, that the theory of a bottle falling from an upper shelf and striking the oven, was the correct one; but he was not certain that a part of the oven might not have been exposed in such a way that a falling bottle could have struck it. He could not give the grade of gun cotton, but stated that the company from whom it was ordered knew of the use to which it was to be put.

Conclusions.

While the cause of the explosion was not definitely established, it seems reasonable to conclude that it was due to the gun cotton. It is

likely that there was more or less of the gun cotton dust in the oven and possibly on the floor, although it was claimed that the floor was cleaned up daily, and even if the explosion was not caused by concussion, from a falling bottle or otherwise, it may have been caused by the overheating of gun cotton dust, which in turn exploded the gun cotton itself. The oven showed that the force of the explosion had been outward.

The following opinion and advice were given by an expert connected with a well-known firm handling large quantities of explosives, to whom the facts were submitted:—

1. The grade of nitrocellulose in question is very insensitive to shock under the conditions named. Therefore, it is our belief that the trouble was not caused by a bottle falling from a shelf on to the oven.

2. All grades of nitrocellulose, of whatever degrees of purity, decompose under the effect of heating—milder temperatures, of course, causing slower decomposition. For the above reason it is always a risky operation to dry nitrocellulose in large amounts by heating. In the present case the time of heating is not stated, but the temperature is given as 140 deg. F., or 60 deg. C. This is not a very severe heat, but might easily cause trouble if continued too long. Unless it is already being done, we would suggest a preliminary drying at 30 deg. C. until the "air dry" condition is reached; then, if there is still too much residual moisture, heat at the higher temperature for not more than 1½ to 2 hours. Also, the six pound charge should be divided up and dried in separate compartments insulated by an air space, or else in separate ovens. Each compartment or oven should be provided with a hinged, unfastened door, besides holes for ventilation. Some mechanical arrangement should be provided for removing and inserting the trays without exposing the operator to the danger of burns from a flare. All steam pipes should be covered to prevent nitrocellulose from settling on them. The room used for drying should be kept clean and free from accumulations of dry nitrocellulose. The building used for the operation should be separated from others by a space of 30 or 40 feet. The room for making up solutions should be in a separate building. If the above precautions are taken, it is our opinion that this firm can continue to dry its nitrocellulose by heating, with slight danger to persons or property. No great increase in scale of operation should be attempted, though, with the above method of drying.

3. Not more than 15 or 20 grams of nitrocellulose should be dried in an oven in a laboratory used for general purposes. The precaution of leaving the oven door unfastened should always be taken.

4. There is a difference in the stability of the grade of nitrocellulose in question, and that used in the highest class of explosive. The difference is so slight, however, that what has been stated above can be taken as applying to one grade as well as to the other.

It is not surprising that some uneasiness is felt in underwriting circles at the prospect of an extension of processes of this kind in connection with tanneries. It is understood that war conditions were mainly responsible for the change from purchase to manufacture on the part of the concern which suffered the loss here reported.

Annual Summary.

Statistics of Fires in Properties Having Automatic Sprinkler Protection.

NOTE.—These tabulations are made at the close of each fiscal year, with the object of furnishing a basis upon which the virtue of the automatic sprinkler as an extinguishing agent can be estimated.

Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.

Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.

In each table the results of the current year ending April 1, 1918, are given, and these are compared with the results of the total twenty-one year record ending at that time.

As was predicted in the introduction to last year's tabulation, the number of fire reports available for inclusion during the current year shows an increase over those of 1916-1917. So far as fires of sufficient intensity to cause sprinklers to operate are concerned, the figure is 1302, as against 1262; while the number of cases in which insufficient heat was generated to open any sprinklers has risen from 289 to 325. Present indications are that the increase in the number of reports received will be maintained in the coming year.

The marked growth in the proportion of fires extinguished in their incipiency before sprinklers operated coincides with a further increase in the proportions occurring in the daytime and immediately discovered. This tendency, which was noted last year also, seems to point to a general improvement in standards of housekeeping.

The severe weather conditions of the year are reflected in the summary of sprinkler failures, which includes no less than 7 cases of equipment crippled by freezing. Tables 2 and 3 afford *prima facie* evidence of a growing appreciation of the value of supervisory systems. Otherwise the tables present no features of unusual interest.

For the purpose of compiling the record of grocery fires published in the October QUARTERLY, a new classification was made in Tables 9 and 10. The necessary adjustments have been made in the figures appearing under "Mercantile," from which group the separately tabulated groceries were taken.

SECTION I.

Summary of Unsatisfactory Sprinkler Fires.

	1917-1918. No. of Fires.	1917-1918. Per Cent.	1897-1918, incl. No. of Fires.	1897-1918, incl. Per Cent.
Water shut off sprinklers	11	25.0	241	26.9
Generally defective equipment	4	9.1	204	22.8
Unsprinklered portions	2	4.5		
Defective heads	2	4.5		
Defective water supply or supplies	2	4.5	85	9.5
Sprinkler system crippled due to freezing	7	15.9	25	2.8
Slow operation of dry system or defective valve	1	2.3	19	2.1
Slow or defective operation of high test heads	2	4.5	17	1.9
Faulty building construction, concealed spaces, vertical openings, etc.	1	2.3	39	4.4
Obstruction to distribution	2	4.5	54	6.0
Hazard of occupancy too severe for average sprinkler equipment	5	11.4	44	4.9
Explosion crippled sprinkler system	3	6.9	37	4.1
Exposure or conflagration	..	..	63	7.1
Miscellaneous	1	2.3	35	3.9
Plugged heads	..	..		
Not classified	1	2.3	32	3.6
Total	44		895	

Special Classification of Fires in Which Failure Was Due to Water Being Shut Off Sprinklers.

	1917-1918. No. of Fires.	1897-1918, incl. No. of Fires.
Water shut off for unknown reason, neglect or carelessness	5	97
Water shut off before fire was out or fire rekindled	2	40
Water shut off due to accidents or repairs	1	38
Water shut off to prevent freezing	3	42
Water shut off, probably incendiary	..	3
Water shut off, leaky dry system	..	11
Water shut off, miscellaneous	..	8
Water shut off, defective gate valve	..	2
Total	11	241

SECTION II.

Annual Revision of Sprinkler Fire Tables.

In the following ten tables is given a summary of fires occurring in properties equipped with automatic sprinklers. The total number of such fires reported during the year was 1,627, which includes 325 fires where no sprinklers were opened. Several reports were also received in which the data was incomplete, and these were not used in this summary.

Table No. 1.

Time of Day.

	No. of Fires. 1917-1918.	No. of Fires. 1897-1918, incl.	Per Cent. of No. with Data Given. 1917-1918.	1897-1918, incl.
6 a. m. to 6 p. m.....	721	10330	56.6	57.7
6 p. m. to 6 a. m.....	553	7579	43.4	42.3
Total with data given...	1274	17909		
No data	28	364		
Total.....	1302	18273		

Table No. 2.

How Discovered.

	No. of Fires. 1917-1918.	No. of Fires. 1897-1918, incl.	Per Cent of No. with Data Given. 1917-1918.	1897-1918, incl.
Employee	755	10583	59.0	59.4
Watchman	156	2696	12.2	15.1
Sprinkler Alarm.....	234	2773	18.3	15.6
Outsider	61	918	4.7	5.2
Thermostats	27	622	2.1	3.5
Automatic Pump.....	1	11	.1	.06
Supervisory System	46	201	3.6	1.14
Total with data given...	1280	17804		
No data	22	469		
Total.....	1302	18273		

Table No. 3.

Efficiency of Alarm Service, 1917-1918.

NOTE.—This table does not include fires where alarm service does or does not operate promptly if fire is at once discovered by employees, the alarm service having no bearing on such fires one way or the other.

	Satisfactory.		Failure.		Total.
	No. of Fires	Per Cent.	No. of Fires	Per Cent.	
Watchman alone	89	90.8	9	9.2	98
Sprinkler Alarm alone.....	134	93.7	9	6.3	143
Thermostats alone.....	2	66.7	1	33.3	3
Supervisory System alone..	3	100.0	..	..	3

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm....	57	69*	120	6	..	..	..	..	126
Watchman and Thermostats	..	1*	..	..	1	..	..	..	1
Sprinkler Alarm and Thermostats	..	..	12	3	12	3	..	..	15
Watchman, Sprinkler Alarm and Thermostats	1	3*	4	..	4	..	..	..	4
Sprinkler Alarm and Supervisory	..	..	32	..	..	..	32	..	32
Watchman and Supervisory	..	2*	..	..	..	..	2	..	2
Watchman, Sprinkler Alarm and Supervisory	8	33*	40	1	..	..	41	..	41
Sprinkler Alarm, Thermostats and Supervisory	..	..	8	..	6	2	8	..	8

Efficiency of Alarm Service, 1897-1918, inclusive.

	Satisfactory.		Failure.		Total.
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	
Watchman alone	1559	89.7	179	10.3	1738
Sprinkler Alarm alone.....	1734	93.8	115	6.2	1849
Thermostats alone.....	182	79.1	48	20.9	230

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm....	1131	762*	1676	217	..	..	..	..	1893
Watchman and Thermostats	19	8*	..	..	25	2	..	..	27
Sprinkler Alarm and Thermostats	..	..	471	38	389	120	..	..	509
Watchman, Sprinkler Alarm and Thermostats	39	65*	97	7	78	26	..	..	104
Sprinkler Alarm and Supervisory	..	..	216	7	..	..	219	4	223
Watchman and Supervisory	5	7*	..	..	..	..	12	..	12
Watchman, Sprinkler Alarm and Supervisory	61	96*	153	4	..	..	154	3	157
Sprinkler Alarm, Thermostats and Supervisory	..	..	36	1	30	7	37	..	37

* These include fires where sprinkler alarm or thermostat notified the watchman.

Table No. 4.

Number of Sprinklers Operating.

No. of Sprinklers Operating.	No. of Fires. 1917-1918.	No. of Fires. 1897-1918 incl.	Per Cent. of No. with Data Given. 1917-1918.	Per Cent. of No. with Data Given. 1897-1918 incl.
1	462	6234	36.4	31.8
2	209	3214	16.5	16.4
3	110	1989	8.7	10.2
4	88	1436	6.9	7.3
5	52	923	4.1	4.7
6	53	788	4.2	4.0
7	34	497	2.7	2.5
8	21	498	1.7	2.5
9	24	337	1.9	1.7
10	23	296	1.8	1.5
11	13	253	1.0	1.3
12	18	284	1.4	1.5
13	13	165	1.0	.8
14	6	183	.5	.9
15	8	151	.6	.8
16 to 20	26	520	2.0	2.7
21 to 25	28	347	2.2	1.8
26 to 30	18	236	1.4	1.2
31 to 35	9	145	.7	.7
36 to 40	13	127	1.0	.7
41 to 50	7	174	.6	.9
51 to 75	13	237	1.0	1.2
76 to 100	6	115	.5	.6
Over 100	15	441	1.2	2.3
Total with data given	1269	19590		
Water shut off sprinklers	11	207		
No data	22	300		
Total	1302	20097		

Table No. 5.

Number of Sprinklers Operating.

No. of Sprinklers Operating.	No. of Fires. 1897-1918 incl.	Per Cent. of No. with Data Given. 1897-1918 incl.
1	6234	31.8
2 or less	9448	48.2
3 or less	11437	58.4
4 or less	12873	65.7
5 or less	13796	70.4
6 or less	14584	74.4
7 or less	15081	76.9
8 or less	15579	79.4
9 or less	15916	81.1
10 or less	16212	82.6
11 or less	16465	83.9

No. of Sprinklers Operating	No. of Fires 1897-1918 incl.	Per Cent. of No. with Data Given 1897-1918 incl.
12 or less	16749	85.4
13 or less	16914	86.2
14 or less	17097	87.1
15 or less	17248	87.9
20 or less	17768	90.6
25 or less	18115	92.4
30 or less	18351	93.6
35 or less	18496	94.3
40 or less	18623	95.0
50 or less	18797	95.9
75 or less	19034	97.1
100 or less	19149	97.7
Over 100	441	2.3
Total with data given	19590	
Water shut off sprinklers	207	
No data	300	
Total	20097	

Table No. 6.

Sprinklers Opened on Wet or Dry Systems.

	No. of Fires. 1917-1918.	No. of Fires. 1897-1918, incl.	Per Cent. of No. with Data Given. 1917-1918.	Per Cent. of No. with Data Given. 1897-1918, incl.
Wet System	1056	14330	83.7	80.7
Dry System	205	3421	16.3	19.3
Total with data given	1261	17751		
Water shut off system	11	207		
No data	30	315		
Total	1302	18273		

Table No. 7.

Primary Water Supplies to Sprinklers Opened.

	No. of Fires. 1917-1918.	No. of Fires. 1897-1918, incl.	Per Cent. of No. with Data Given. 1917-1918.	Per Cent. of No. with Data Given. 1897-1918, incl.
Waterworks	654	9158	52.0	51.7
Gravity Tank	330	4754	26.2	26.9
Pressure Tank	210	2806	16.7	15.8
Automatic Steam Pump	56	969	4.5	5.49
Automatic Electric Pump	7	17	.6	.092
Steamer Connection	0	3	..	.018
Total with data given	1257	17707		
Water shut off system	11	207		
No data	34	369		
Total	1302	18283		

Table No. 8.

Effect of Sprinklers.

	No. of Fires. 1917-1918.	No. of Fires. 1897-1918. incl.	Per Cent. of Whole. 1917-1918	Per Cent. of Whole. 1897-1918, incl.
Practically or entirely extinguished	909	13103	69.82	65.20
Held fire in check	349	6099	26.80	30.35
	1258	19202	96.62	95.55
Unsatisfactory	44	895	3.38	4.45
Total	1302	20097		

Table No. 9.

Showing Effect of Sprinklers by Class of Occupancy.

	Extinguished Fire.		Held Fire in Check.		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Agricultural Implements	46	61.3	26	34.7	72	96.0	3	4.0	75
Alcohol (Wood) Plant	..	..	1	100.0	1	100.0	..	..	1
Automobile and Bicycle Factories	70	60.9	39	33.9	109	94.8	6	5.2	115
Awning Factories	5	100.0	..	...	5	100.0	..	..	5
Bag Factories	5	62.5	3	37.5	8	100.0	..	..	8
Bakeries	37	68.5	15	27.8	52	96.3	2	3.7	54
Basket Factories	7	100.0	..	...	7	100.0	..	..	7
Bolt, Nut and Screw Works	15	78.9	4	21.1	19	100.0	..	..	19
Boot and Shoe Shops	402	74.3	118	21.8	520	96.1	21	3.9	541
Bottling Works	4	100.0	..	...	4	100.0	..	..	4
Braiding Mills	6	85.7	1	14.3	7	100.0	..	..	7
Breweries	5	83.4	1	16.6	6	100.0	..	..	6
Broom Factories	8	61.5	3	23.1	11	84.6	2	15.4	13
Brush Factories	10	83.3	2	16.7	12	100.0	..	..	12
Button Manufactories	21	87.5	2	8.3	23	95.8	1	4.2	24
Candle Factories	4	44.4	5	55.6	9	100.0	..	..	9
Candy Factories	64	73.6	22	25.3	86	98.9	1	1.1	87
Canning Works	7	70.0	2	20.0	9	90.0	1	10.0	10
Car Houses	23	48.9	19	40.4	42	89.3	5	10.7	47
Car Works	57	66.3	26	30.2	83	96.5	3	3.5	86
Carpet Mills	122	59.2	75	36.4	197	95.6	9	4.4	206
Carriage Factories	86	66.1	37	28.5	123	94.6	7	5.4	130
Celluloid (Pyroxylin Plastic)	93	69.4	25	18.7	118	88.1	16	11.9	134
Cement and Plaster Works	2	66.7	..	...	2	66.7	1	33.3	3
Cereal Mills	28	68.3	8	19.5	36	87.8	5	12.2	41
Chemical and White Lead	46	56.1	30	36.6	76	92.7	6	7.3	82
Clothing Factories	467	80.2	108	18.6	575	98.8	7	1.2	582
Coffee and Spice Mills	35	72.9	13	27.1	48	100.0	..	..	48
Coffin Factories	34	77.3	9	20.4	43	97.7	1	2.3	44
Cold Storage Plants	4	50.0	4	50.0	8	100.0	..	..	8
Cooperage Plants	41	54.0	26	34.2	67	88.2	9	11.8	76
Cordage Works	183	66.3	84	30.4	267	96.7	9	3.3	276
Cork Factories	7	53.9	4	30.7	11	84.6	2	15.4	13
Corset Factories	5	55.6	3	33.3	8	88.9	1	11.1	9
Cotton Ginnery	10	66.7	5	33.3	15	100.0	..	..	15
Cotton Mills	3116	61.7	1879	37.2	4995	98.9	57	1.1	5052
Cotton Warehouses	102	45.9	99	44.6	201	90.5	21	9.5	222
Cotton Seed Oil Mills	36	52.9	21	30.9	57	83.8	11	16.2	68
Cutlery and Tools	8	50.0	7	43.8	15	93.8	1	6.2	16

Table No. 9—Continued.

	Extinguished Fire		Held Fire in Check.		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Department Stores	291	80.0	62	17.0	353	97.0	11	3.0	364
Distilleries	7	77.8	2	22.2	9	100.0	..	..	9
Drug Houses	118	81.3	23	15.9	141	97.2	4	2.8	145
Dry Cleaning Establishments	4	80.0	1	20.0	5	100.0	..	..	5
Dyeing, Bleaching and Finishing	102	49.7	93	45.4	195	95.1	10	4.9	205
Electrical Appliances	98	75.4	28	21.5	126	96.9	4	3.1	130
Electric Light and Power Plants	2	33.4	2	33.3	4	66.7	2	33.3	6
Elevators, Grain	20	36.4	20	36.4	40	72.8	15	27.2	55
Excelsior Factories	21	77.8	5	18.5	26	96.3	1	3.7	27
Fertilizer Plants	16	64.0	7	28.0	23	92.0	2	8.0	25
Flax and Linen Mills	18	48.6	19	51.4	37	100.0	..	..	37
Flour and Grist Mills	43	56.6	26	34.2	69	90.8	7	9.2	76
Forge and Smithy	11	78.6	3	21.4	14	100.0	..	..	14
Foundries	105	56.5	72	38.7	177	95.2	9	4.8	186
Furniture Factories	371	64.6	155	27.0	526	91.6	48	8.4	574
Garages	52	67.5	22	28.6	74	96.1	3	3.9	77
Garbage Reduction Plants	3	60.0	1	20.0	4	80.0	1	20.0	5
Gas Plants	2	100.0	..	...	2	100.0	..	..	2
Glass Works	38	59.4	22	34.4	60	93.8	4	6.2	64
Glove Factories	8	88.9	1	11.1	9	100.0	..	..	9
Glue Factories	4	44.5	3	33.3	7	77.8	2	22.2	9
Groceries	42	79.2	7	13.2	49	92.4	4	7.6	53
Harness and Fanry Leather	53	79.1	14	20.9	67	100.0	..	..	67
Hat, Fur	40	70.2	12	21.0	52	91.2	5	8.8	57
Hat, Straw	12	57.1	9	42.9	21	100.0	..	..	21
Hatters' Fur Mfg	9	64.3	5	35.7	14	100.0	..	..	14
Ice Plants	1	100.0	..	...	1	100.0	..	..	1
Incandescent Lamp Factories	10	55.6	8	44.4	18	100.0	..	..	18
Insulated Wire Factories	24	68.6	11	31.4	35	100.0	..	..	35
Jewelry Shops	94	87.9	9	8.4	103	96.3	4	3.7	107
Junk Shops	7	87.5	1	12.5	8	100.0	..	..	8
Knitting Mills, Cop Yarn	38	60.3	19	30.2	57	90.5	6	9.5	63
Knitting Mills, Full Process	394	64.1	198	32.2	592	96.3	23	3.7	615
Laundries	27	62.8	14	32.6	41	95.4	2	4.6	43
Lead Pencil Factories	11	64.7	6	35.3	17	100.0	..	..	17
Linseed Oil Works	13	59.1	8	36.4	21	95.5	1	4.5	22
Machine Shops	232	65.9	102	29.0	334	94.9	18	5.1	352
Match Factories	42	72.4	12	20.7	54	93.1	4	6.9	58
Mattress Factories	217	73.6	73	24.7	290	98.3	5	1.7	295
Mercantile*	540	79.4	125	18.4	665	97.8	15	2.2	680
Metal Reduction Works	3	75.0	1	25.0	4	100.0	..	..	4
Metal Workers	487	64.8	228	30.4	715	95.2	36	4.8	751
Miscellaneous	255	69.5	96	26.1	351	95.6	16	4.4	367
Morocco Leather Shops	9	37.5	11	45.8	20	83.3	4	16.7	24
Motion Picture Theatres	19	73.1	7	26.9	26	100.0	..	..	26
Munition Factories	7	30.4	10	43.5	17	73.9	6	26.1	23
Musical Instrument Factories	84	68.3	35	28.5	119	96.8	4	3.2	123
Oil Clothing Factories	9	75.0	3	25.0	12	100.0	..	..	12
Oilcloth and Linoleum Works	22	27.8	41	51.9	63	79.7	16	20.3	79
Oil Refineries	4	40.0	6	60.0	10	100.0	..	..	10
Packing House and Slaughter	66	66.0	31	31.0	97	97.0	3	3.0	100
Paint and Color Works	113	71.5	40	25.3	153	96.8	5	3.2	158
Paper Box and Papeterie	90	74.4	30	24.8	120	99.2	1	.8	121
Paper Mills	256	51.4	192	38.6	448	90.0	50	10.0	498
Patent Leather Works	6	40.0	7	46.7	13	86.7	2	13.3	15
Picture Frame Factories	31	64.6	13	27.1	44	91.7	4	8.3	48

* The new classification "Groceries" has been taken from the "Mercantile" group this year.

Table No. 9—Concluded.

	Extinguished Fire		Held Fire in Check.		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Plumbers' Supplies	12	80.0	3	20.0	15	100.0	..	..	15
Potteries	36	65.5	17	30.9	53	96.4	2	3.6	55
Printing and Lithographing	352	80.0	75	17.0	427	97.0	13	3.0	440
Pulp, Miscellaneous	7	29.2	12	50.0	19	79.2	5	20.8	24
Pulp, Soda	1	20.0	1	20.0	2	40.0	3	60.0	5
Pulp, Sulphite	16	41.0	16	41.0	32	82.0	7	18.0	39
Restaurants	13	86.7	2	13.3	15	100.0	..	..	15
Rice Mills	..	...	1	100.0	1	100.0	..	..	1
Rolling, Wire and Tube Works	17	53.1	14	43.8	31	96.9	1	3.1	32
Roofing Works	13	39.4	19	57.6	32	97.0	1	3.0	33
Rubber Cloth Factories	14	63.6	8	36.4	22	100.0	..	..	22
Rubber Reclaiming Works	3	27.3	7	63.6	10	90.9	1	9.1	11
Rubber Works	90	52.6	73	42.7	163	95.3	8	4.7	171
Saw and Planing Mills	61	42.4	47	32.6	108	75.0	36	25.0	144
Shirt Factories	30	81.1	7	18.9	37	100.0	..	..	37
Shoddy Mills	150	65.8	63	27.6	213	93.4	15	6.6	228
Silk Mills	34	68.0	13	26.0	47	94.0	3	6.0	50
Skin Mills	2	66.7	1	33.3	3	100.0	..	..	3
Soap Manufacturing	21	80.8	4	15.4	25	96.2	1	3.8	26
Stamping & Sheet Metal Works	31	57.4	18	33.3	49	90.7	5	9.3	54
Starch and Glucose Mills	9	47.4	4	21.0	13	68.4	6	31.6	19
Sticky Fly Paper Factories	3	75.0	1	25.0	4	100.0	..	..	4
Sugar Refineries	15	65.2	7	30.4	22	95.6	1	4.4	23
Tanneries	33	52.4	25	39.7	58	91.1	5	7.9	63
Tenant Manufacturing	386	70.6	134	24.5	520	95.1	27	4.9	547
Theatres	35	79.5	8	18.2	43	97.7	1	2.3	44
Tobacco Factories	37	63.8	18	31.0	55	94.8	3	5.2	58
Trunk Factories	8	72.7	3	27.3	11	100.0	..	..	11
Varnish Works	4	57.1	1	14.3	5	71.4	2	28.6	7
Wall Paper Factories	11	68.8	2	12.5	13	81.3	3	18.7	16
Warehouses	191	69.7	68	24.8	259	94.5	15	5.5	274
Waste and Batting Mills	192	64.2	99	33.1	291	97.3	8	2.7	299
Waste Paper and Rag Shops	34	66.6	16	31.4	50	98.0	1	2.0	51
Weaving Mills	88	64.2	45	32.9	133	97.1	4	2.9	137
Whip Factories	3	60.0	2	40.0	5	100.0	..	..	5
Window Shades Factories	9	90.0	..	...	9	90.0	1	10.0	10
Woodworkers, Class A*	106	53.2	67	33.7	173	86.9	26	13.1	199
Woodworkers, Class B*	113	50.9	87	39.2	200	90.1	22	9.9	222
Woodworkers, Class C*	91	58.7	54	34.8	145	93.5	10	6.5	155
Woodworkers, Class D*	70	59.3	33	28.0	103	87.3	15	12.7	118
Woodworkers, Class E*	85	61.1	45	32.4	130	93.5	9	6.5	139
Woodworkers, Class F*	28	65.1	12	27.9	40	93.0	3	7.0	43
Woolen Mills	766	71.2	257	23.9	1023	95.1	53	4.9	1076
Wool Storehouses	23	69.7	8	24.2	31	93.9	2	6.1	33
Worsted Mills	38	50.7	25	33.3	63	84.0	12	16.0	75
Total Sprinkler Fires	13,103		6,099		19,202		895		20,097

* The Woodworkers are classed as follows:
Class A. Interior woodwork, builders' supplies (including veneer works).
Class B. Box factories (including cigar boxes).
Class C. Miscellaneous Woodworkers. Steam power tenant woodworkers (also woodworkers where there is a lack of detailed information as to class).
Class D. Sash, Door and Blind Factories.
Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).
Class F. Pails and Woodenware. (Plates, wooden bowls, tubs, etc.).

Table No. 10.

Classification of Unsatisfactory Sprinkler Fires by Occupancy.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Agricultural Implements..	2	..	..	..	..	..	..	..	1	..	..	..	..	3
Automobile and Bicycle...	2	1	..	..	..	..	..	2	..	..	1	..	..	6
Bakeries	..	1	..	..	..	..	..	..	..	..	..	1	..	2
Boot and Shoe Shops....	7	2	2	..	..	1	..	1	..	2	5	..	1	21
Broom Factories.....	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Button Factories.....	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Candy Factories.....	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Canning Works	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Car Houses	1	1	1	..	1	..	..	1	..	..	..	..	..	5
Car Works	1	1	..	..	..	..	..	1	..	..	..	..	..	3
Carpet Mills	4	1	3	..	..	..	..	1	..	..	..	..	..	9
Carriage Factories	..	1	2	..	1	..	..	1	..	..	2	..	..	7
Celluloid (Pyroxylin) ..	..	..	2	1	1	..	1	..	7	3	1	..	..	16
Cement & Plaster Works.	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Cereal Mills.....	..	2	1	..	..	..	..	..	..	2	..	..	..	5
Chemical & White Lead..	1	3	..	..	..	..	..	..	..	2	..	..	..	6
Clothing Factories.....	3	..	1	..	..	..	2	1	..	..	..	..	..	7
Coffin Factories	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Cooperage Plants	1	3	..	..	..	1	..	3	..	..	1	..	..	9
Cordage Works	2	3	1	..	..	..	..	2	..	..	..	..	1	9
Cork Factories	1	..	..	..	..	..	..	..	..	1	..	..	..	2
Corset Factories	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Cotton Mills	22	13	6	1	..	1	4	1	1	..	..	4	4	57
Cotton Warehouses	12	1	2	..	..	..	1	3	1	..	..	1	..	21
Cotton Seed Oil Mills....	2	4	2	..	..	..	..	..	..	..	..	2	1	11
Cutlery and Hardware...	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Department Stores.....	4	3	..	..	..	..	..	1	..	..	2	..	1	11
Drug Houses.....	..	..	..	..	..	..	..	..	..	..	3	1	..	4
Dyeing, Bleaching and Finishing	3	2	1	..	..	1	..	1	..	..	1	..	1	10
Electrical Appliances	1	..	2	..	..	..	..	..	..	..	..	..	1	4
Electric Light and Power Plants	..	1	..	..	..	..	..	1	..	..	..	..	..	2
Elevators, Grain.....	..	3	3	..	1	..	2	1	1	1	2	..	1	15
Excelsior Factories.....	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Fertilizer Plants	1	..	..	..	1	..	..	..	..	..	..	..	..	2
Flour and Grist Mills....	..	1	1	..	..	..	1	..	..	2	2	..	..	7
Foundries	6	1	1	..	..	..	..	..	..	1	..	..	..	9
Furniture Factories.....	12	12	2	3	..	..	2	9	6	..	2	..	..	48
Garages	1	..	..	..	..	..	..	2	..	..	..	..	..	3
Garbage Reduction Plants	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glass Works.....	1	1	..	..	..	..	..	..	..	..	..	..	2	4
Glue Factories.....	1	..	..	..	..	..	..	..	1	..	..	..	..	2
Groceries	3	..	..	..	1	..	..	..	..	..	..	..	..	4
Hat, Fur.....	1	2	1	..	1	..	..	..	..	..	..	..	..	5

Table No. 10—Continued.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Jewelry Shops	2	1	..	1	..	..	..	..	..	..	..	..	..	4
Knitting, Cop Yarn	..	1	3	..	..	..	..	1	..	1	..	..	..	6
Knitting, Full Process	6	9	5	1	1	..	..	..	..	1	..	..	..	23
Laundries	1	..	..	..	..	..	..	1	..	..	..	..	..	2
Linseed Oil Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Machine Shops	11	3	..	1	..	1	..	1	..	1	..	..	..	18
Match Factories	2	..	..	..	..	..	..	..	1	..	..	1	..	4
Mattress Factories	2	1	..	1	..	..	..	1	..	..	..	..	..	5
Mercantile*	5	2	..	1	..	..	2	..	..	..	4	..	1	15
Metal Workers	12	13	2	..	..	..	1	..	1	2	2	1	2	36
Miscellaneous	2	3	2	1	1	..	2	..	2	..	2	1	..	16
Morocco Leather Shops	1	2	..	..	..	..	1	..	..	..	..	..	..	4
Munitions Factories	2	..	..	..	..	..	..	..	3	..	..	1	..	6
Musical Instrument Factories	..	3	..	..	..	..	..	..	..	..	1	..	..	4
Oilcloth and Linoleum Works	..	3	..	..	..	..	1	1	11	..	..	..	..	16
Packing House and Slaughter	1	1	1	..	..	..	..	..	..	..	..	..	..	3
Paint and Color Works	1	2	1	..	..	..	1	..	..	..	..	..	..	5
Paper Box and Papeterie	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Paper Mills	10	17	4	3	..	2	2	..	1	1	2	5	3	50
Patent Leather Works	1	..	..	..	..	..	1	..	..	..	..	..	..	2
Picture Frame Factories	1	2	..	..	..	..	..	1	..	..	..	..	..	4
Potteries	..	..	..	1	..	..	..	..	..	1	..	..	..	2
Printing & Lithographing	4	4	1	..	..	..	..	..	..	..	3	1	..	13
Pulp, Miscellaneous	1	1	2	..	..	..	..	..	..	1	..	..	..	5
Pulp, Soda	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Pulp, Sulphite	3	1	..	..	1	1	..	..	..	..	..	..	1	7
Rolling, Wire and Tube Works	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Roofing Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Rubber Reclaiming Works	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Rubber Works	4	..	..	1	..	..	..	..	2	1	..	..	..	8
Saw and Planing Mills	8	7	1	..	3	1	6	2	1	..	4	1	2	36
Shoddy Mills	5	1	5	..	..	3	..	..	..	..	..	1	..	15
Silk Mills	1	1	..	..	..	..	..	..	..	1	..	..	..	3
Soap Manufacturing	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Stamping and Sheet Metal Works	..	2	1	..	1	..	..	..	..	..	1	..	..	5
Starch and Glucose Mills	..	..	..	..	..	..	..	..	1	5	..	..	..	6
Sugar Refinery	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Tanneries	1	..	..	2	..	..	..	..	..	..	1	..	1	5
Tenant Manufacturing	10	5	2	..	1	..	1	1	..	..	6	..	1	27
Theatres	1	..	..	..	..	..	..	..	..	..	..	..	..	1

* The new classification "Groceries" has been taken from the "Mercantile" group this year.

Table No. 10—Concluded.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Tobacco Factories.....	1	1	..	..	..	..	..	..	..	..	1	..	..	3
Varnish Works	..	..	1	..	..	..	..	..	1	..	..	..	..	2
Wall Paper Factories....	..	..	1	..	..	..	..	1	..	..	1	..	..	3
Warehouses	8	2	1	..	1	..	..	2	..	..	..	..	1	15
Waste and Batting Mills.	1	3	1	..	..	1	..	1	..	..	..	1	..	8
Waste Paper and Rag Shops	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Weaving Mills.....	1	1	1	1	..	..	..	..	..	..	..	..	..	4
Window Shade Factories.	..	..	..	..	..	..	..	..	1	..	..	..	..	1
Woodworkers, Class A*..	5	8	..	..	..	..	..	5	..	2	3	3	..	26
Woodworkers, Class B*..	5	6	2	1	..	1	1	1	..	2	2	1	..	22
Woodworkers, Class C*..	3	4	1	..	..	..	..	2	..	..	..	..	..	10
Woodworkers, Class D*..	1	6	..	1	..	..	..	..	..	1	3	3	..	15
Woodworkers, Class E*..	3	1	..	..	2	1	2	..	..	..	..	..	..	9
Woodworkers, Class F*..	2	..	..	..	..	..	..	1	..	..	..	..	..	3
Woolen Mills.....	10	15	10	1	..	2	3	..	1	..	3	4	4	53
Wool Storehouses	..	2	..	..	..	..	..	..	..	..	..	..	..	2
Worsted Mills	2	3	2	1	..	..	..	..	..	..	..	2	2	12
Total Unsatisfactory Fires	241	204	85	25	19	17	39	54	44	37	63	35	32	895

* See detailed classification of woodworkers as given in note under Table No. 9.

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